WATER MASTER PLAN

FOR

THE COUNTY OF MAUI

STATE OF HAWAII

R.M. TOWILL CORPORATION
Engineers–Surveyors

WATER MASTER PLAN

FOR

COUNTY OF MAUI.

STATEMENT

The preparation of this comprehensive Water Master Plan for the County of Maui has been financed in part by the Department of Housing and Urban Development under the provisions of Section 701 of the Housing Act of 1954 as amended.

Prepared by

R. M. Towill Corporation.

December 1971

R. M. TOWILL CORPORATION

Honolulu Yokohama Guam

CIVIL ENGINEERS
SURVEYORS
HYDROGRAPHERS
PHOTOGRAMMETRIC ENGINEERS
AERIAL PHOTOGRAPHERS

December 30, 1971

Mr. Howard K. Nakamura
Planning Director
County of Maui
Planning Department
P. O. Box 1487
Kahalui, Maui, Hawaii 96732

Dear Mr. Nakamura:

It is a pleasure to forward to you the Water Master Plan for the County of Maui. Development of this final plan has been based on previous reviews by representatives of the Board of Water Supply, and their participation is reflected in all phases of the Water Plan development.

The planning carried forth by our staff in this program has been directed towards providing the County of Maui with a Water Development Plan which is in keeping with the overall growth conditions anticipated by the County of Maui Planning Department.

Our staff has generated considerable interest in the evolution of this plan, and we look forward to its use and implementation. The assistance, participation and cooperation of your staff and the staff of the Board of Water Supply and the Department of Land and Natural Resources, State of Hawaii is greatly appreciated.

Very truly yours,

R. M. TOWILL CORPORATION

Stanley T. Yamanaka

Stanley T. Yamanaka
Acting Manager, Engineering Department

FJD:C23/05

1600 KAPIOLANI BOULEVARD, HONOLULU, HAWAII 96814 TELEPHONE (808) 955-1131 CABLE ADDRESS "TOCOR"

WATER MASTER PLAN

COUNTY OF MAUI

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COUNTY OF MAUI
WATER MASTER PLAN

LEGEND

R. M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

I. OVERALL PLAN DEVELOPMENT

A. PURPOSE

The purpose of this report is to provide the County of Maui with a comprehensive Water Master Plan for those areas presently planned for urban development within the next twenty-year period as well as those areas which are directly related and established as part of the overall area network. This engineering study establishes design criteria, specifies capacity, types and locations of water facilities, previews priorities of construction, includes preliminary cost estimates and provides for methods of funding.

Preparation of this Water Master Plan is in keeping with the General Plan for Development as adopted by the County of Maui; present Public Health Regulations as established by the Department of Health, State of Hawaii; Rules and Regulations of the Public Health Service; and the Rules and Regulations of the Maui Board of Water Supply.

It is intended that this report be utilized by and in cooperation with government agencies and private concerns participating in the water programs for the County of Maui.

B. AUTHORIZATION

The R. M. Towill Corporation has been authorized by the County of Maui under Contract No. 881 to prepare this Water Master Plan.

Funding for the preparation of this Water Master Plan has been financed in part by the Federal Government under Section 701 of the Housing Act of 1954 as amended. The State of Hawaii, Department of Planning and Economic Development, has also participated in the financing of the project under Appropriation 63 B 70 411 V.

C. AREA LOCATION AND DESCRIPTION

Encompassing four islands, Maui, Molokai, Lanai and Kahoolawe, the County of Maui forms the geographic center of the Hawaiian Islands as illustrated on Plate 1. The County of Maui is the second largest county in the State of Hawaii and has a total land area of approximately 1,160 square miles. The largest of the islands, Maui, has a land area of some 728 square miles. It is the center of trade and tourism and the seat of the County government.

The great mountain range that constitutes the Hawaiian Archipelago, has been built almost entirely by volcanic activities. Each of the islands is atop an enormous volcanic mountain, modified by stream and wave erosion and minor amounts of organic growth. The islands comprising the County of Maui are part of a huge volcanic massif consisting of one minor and at least six major volcanoes. At present, the low saddles between volcanoes are flooded by the shallow sea water thus dividing the massif into these four separate islands. At times of lower sea level, in the geological recent past, all of the islands have united as a single large island called Maui Nui.

The Hawaiian Islands have a cooler temperature than other regions of the same latitude, because currents from the Bering Sea lower the water temperature by approximately 10°F. Throughout Hawaii, the weather is generally warm and pleasant the year around. There are variations in temperature and rainfall depending more on location than the season. On Maui, Molokai and Lanai the weather ranges from a warm, dry climate

in the beach areas to almost semi-tropical warmth and heavy rainfall on the windward mountain slopes. At Wailuku on the Island of Maui, at an elevation of approximately 200 feet, the mean temperature is 75°F compared to the Haleakala Observatory, located at an elevation of 10,000 feet, where the mean temperature is 40°F. The average mean temperature decreases 3°F to 4°F for every 1,000 feet rise in altitude.

The persistent northeasterly trade winds and the topography of the islands are the two interrelating factors that determine the orographic rainfall characteristics for the area. The high mountains act as a barrier to the moisture-laden tradewinds. Condensation and cooling of the air as it rises to the higher elevations results in precipitation. The maximum precipitation occurs between altitudes of 2,000 and 6,000 feet depending upon the form and height of each island. Where the mountains are high and massive, such as the conditions of the East Maui Mountains, the precipitation normally occurs on the windward slopes with the leeward areas being rather dry and receiving little if no rainfall. Where the trade winds tend to flow around the higher mountains and over lower mountains, precipitation occurs on the leeward side. It is generally a characteristic of all the islands, however, that the leeward sides of the islands experience less rain and wind than the windward sides.

Exceptions to the rainfall patterns occur during cyclonic storms. These storms usually approach from the south and are called "Kona Storms". Kona Storms normally occurring during the winter months may bring heavy rainfall lasting for several days. During a single Kona Storm more rainfall may be accounted for on the leeward slopes than the entire precipitation

generated for the rest of the year.

With nearly 50,000 residents, Maui is the third most populous county in the State. For purposes of this report, the anticipated population at the end of the year 1990 has been based on the General Plan estimates which were established by the County of Maui. The ultimate land use for each area is specified by the County Master Plan. Equivalent projected population figures developed in this report are similar to those anticipated by the County of Maui.

Pineapple, sugar and tourism are the three largest industries in the County. There are three sugar companies on Maui, and one operates the largest sugar cane plantation in the United States. Maui's wide range of temperature and rainfall makes possible the growing of a variety of fruits and vegetables, as well as the raising of livestock. Presently, the County raises approximately one-fifth of the cattle, one-third of the vegetables and over two-thirds of the pineapple grown in the State of Hawaii. Completion by the State of the large scale irrigation project on Molokai and expanded water service on Maui will serve to enlarge the role of diversified agriculture in the County.

Today, tourism is becoming an increasingly important factor in the economy of the County. It is estimated that approximately twenty-five percent of the visitors to the State visit Maui. Because of the County's strategic location and visitor amenities, it is expected that both the percentage of visitors and their average length of stay will continue to increase. Evidence of the confidence now being placed in Maui's tourist industry is reflected in the continued construction programs throughout the County; particularly in the areas of Kihei and Lahaina.

COUNTY OF MAUI

WATER MASTER PLAN

LOCATION MAP

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CIVIL ENGINEERS - SURVEYORS

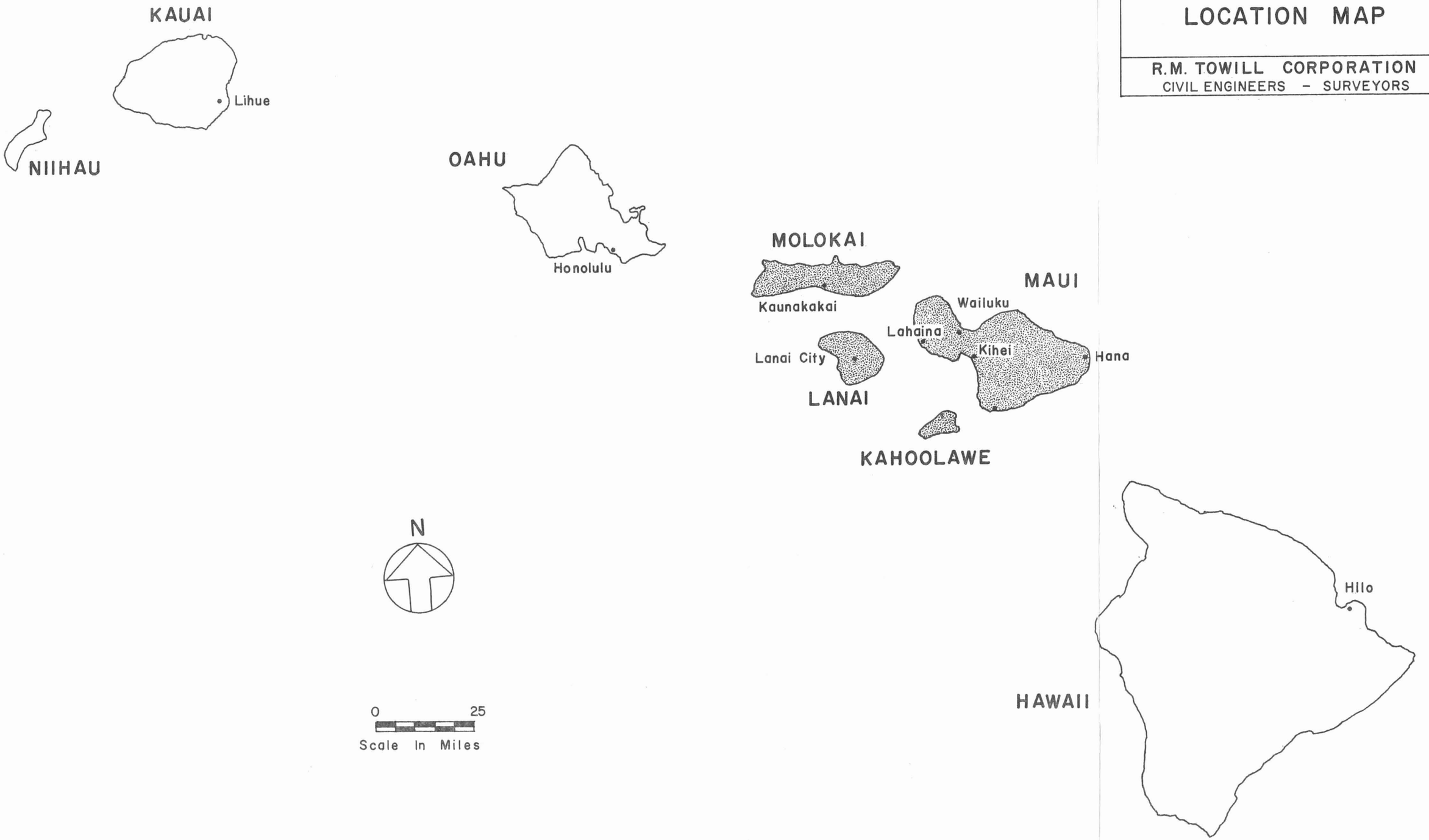
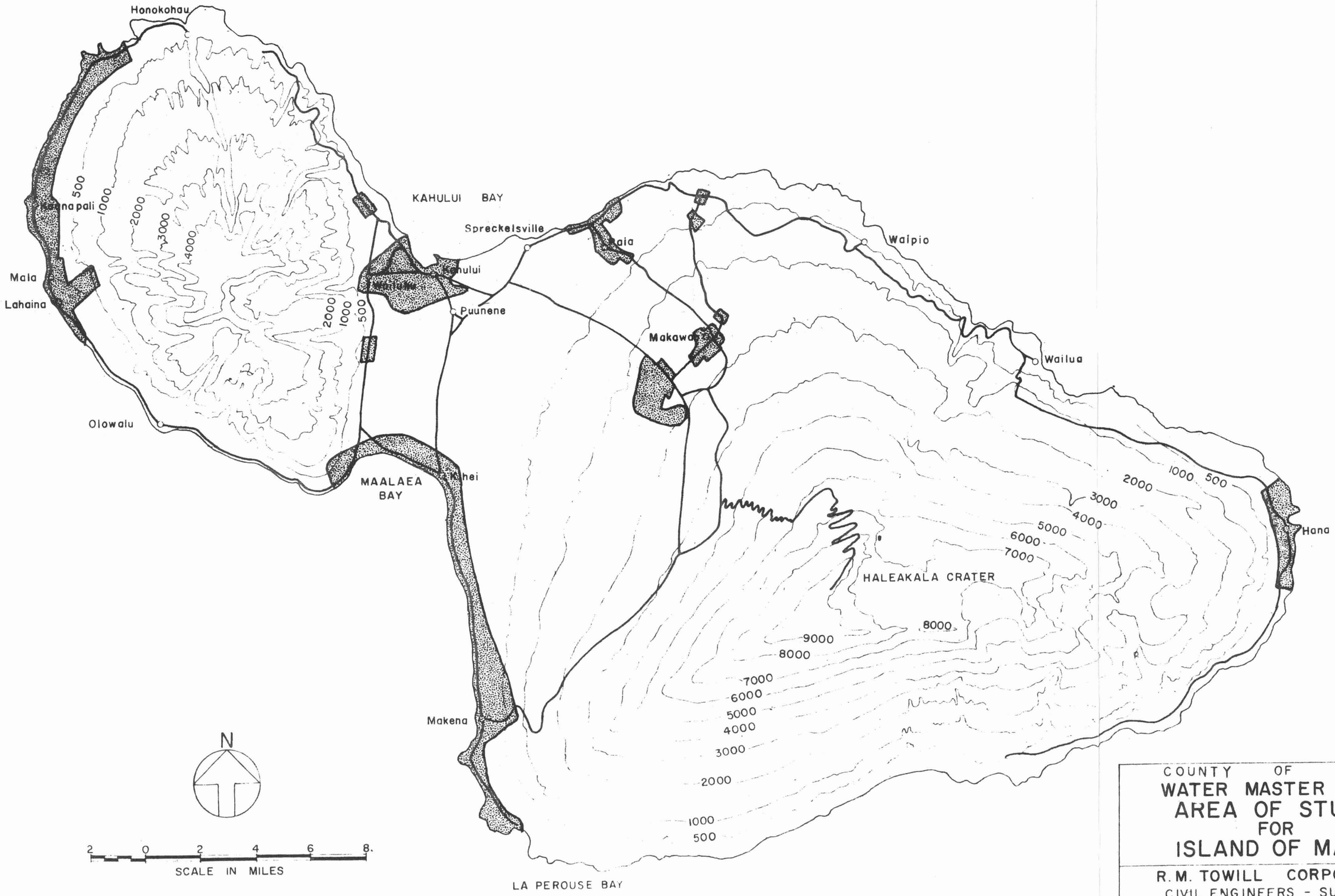


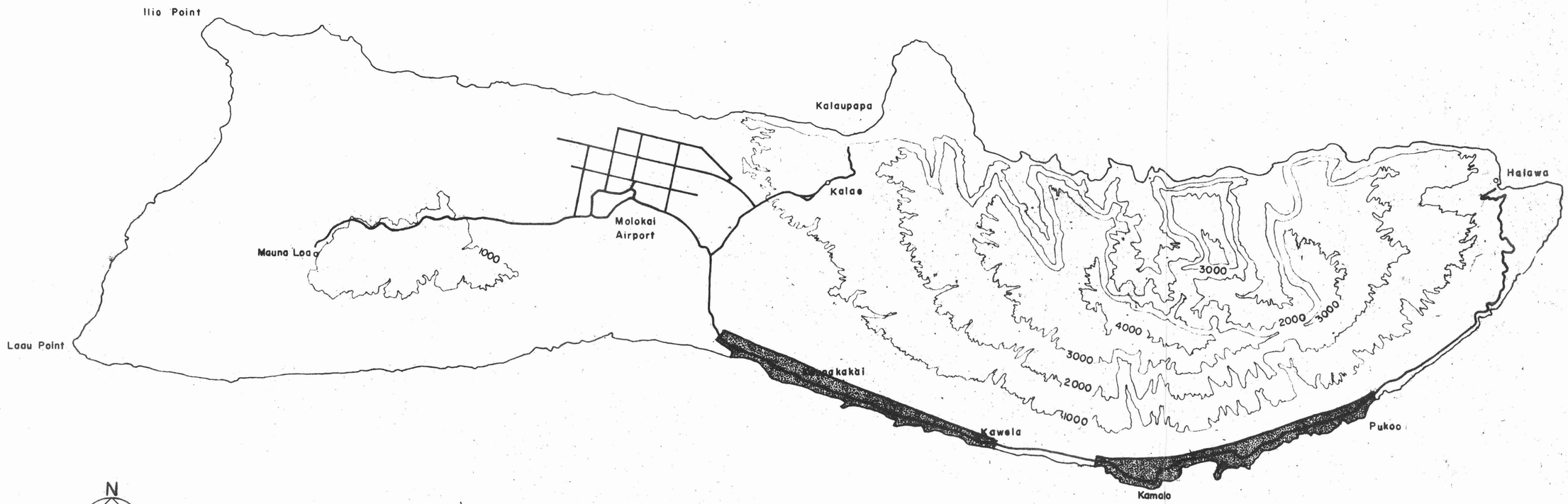
PLATE I



COUNTY OF MAUI
WATER MASTER PLAN
AREA OF STUDY FOR ISLAND OF MAUI

R. M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

PLATE 2



COUNTY OF MAUI
WATER MASTER PLAN
AREA OF STUDY
FOR
ISLAND OF MOLOKAI

R. M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

PLATE 3

D. OVERALL AREA OF STUDY

This study encompasses all areas considered for urban development within the next twenty-year period as outlined in the County's General Plans and specified by the County of Maui Planning Department. For those areas where no General Plan has been adopted, the present State Land Use Plan for the area has been utilized for developing the future urban requirements.

The areas of study considered in this report for the Islands of Maui and Molokai are shown on Plates 2 and 3, respectively. The Island of Lanai has a privately operated water supply system not presently under the juristiction of the Maui County Board of Water Supply and the Island of Kahoolawe is uninhabited. The Islands of Lanai and Kahoolawe are therefore not planned for in this report.

A comprehensive plan for the water system for each individual area of study for the Islands of Maui and Molokai is presented in Section I of this report. Individual cost estimates for each of the proposed water transmission and distribution systems, storage facilities, and source development are presented in Section II of this report. The adopted design criteria upon which the proposed Water Master Plan has been developed are outlined in Section III.

E. INDIVIDUAL AREA OF STUDY - ISLAND OF MAUI

1. Wailuku - Kahului - Paia

a. Limits of Study

The Wailuku-Kahului-Paukukalo study area, located on the north central isthmus of the island, encompasses some 3,000 acres of land between the west boundary to Kahului Airport and extends approximately one-half mile to Waiehu Stream. The limits of study for this area are illustrated on Plate 4.

Located on the western slopes of Mount Haleakala, the Paia study area encompasses some 650 acres of land, the limits of study for which are illustrated on Plate 6.

The Waihee area is presented in this report on Plate 8 and is considered a part of the general Wailuku-Kahului study area.

b. Economic Conditions

These communities, although separated in name, are in reality one urbanized economic unit that serves as the metropolitan center of Maui. It is anticipated that this area will continue its dominant role as the hub of trade, business and service activities. The major State Airport and deep water harbor are both located in Kahului. These two facilities can only enhance the potential economic growth of the area.

Residential development in Kahului is continuing, and it is possible that some additional area, not included in the present County's General Plan, may be scheduled for development as residential sites.

Sugar and pineapple are the two major industries for the area. The town of Paia is the local commercial shopping area and the residential community for many of the people employed by the cane and pineapple industry. Paia might also emerge as the commercial center for the possible future development of new communities east of Paia, along the Hana Road.

Waihee primarily serves as a "country store" and a minor residential area within the vast sea of cane field agricultural lands.

c. Land Use and Water Demand Areas

The County's General Plan for development of the Wailuku-Kahului-Paukukalo area is illustrated on the Land Use Map, Plate 4. Table I-1 summarizes the number of acres allotted for each type of zoning classification. Each individual water demand area is illustrated on Plate 5 and listed in tabular form on Table I-2.

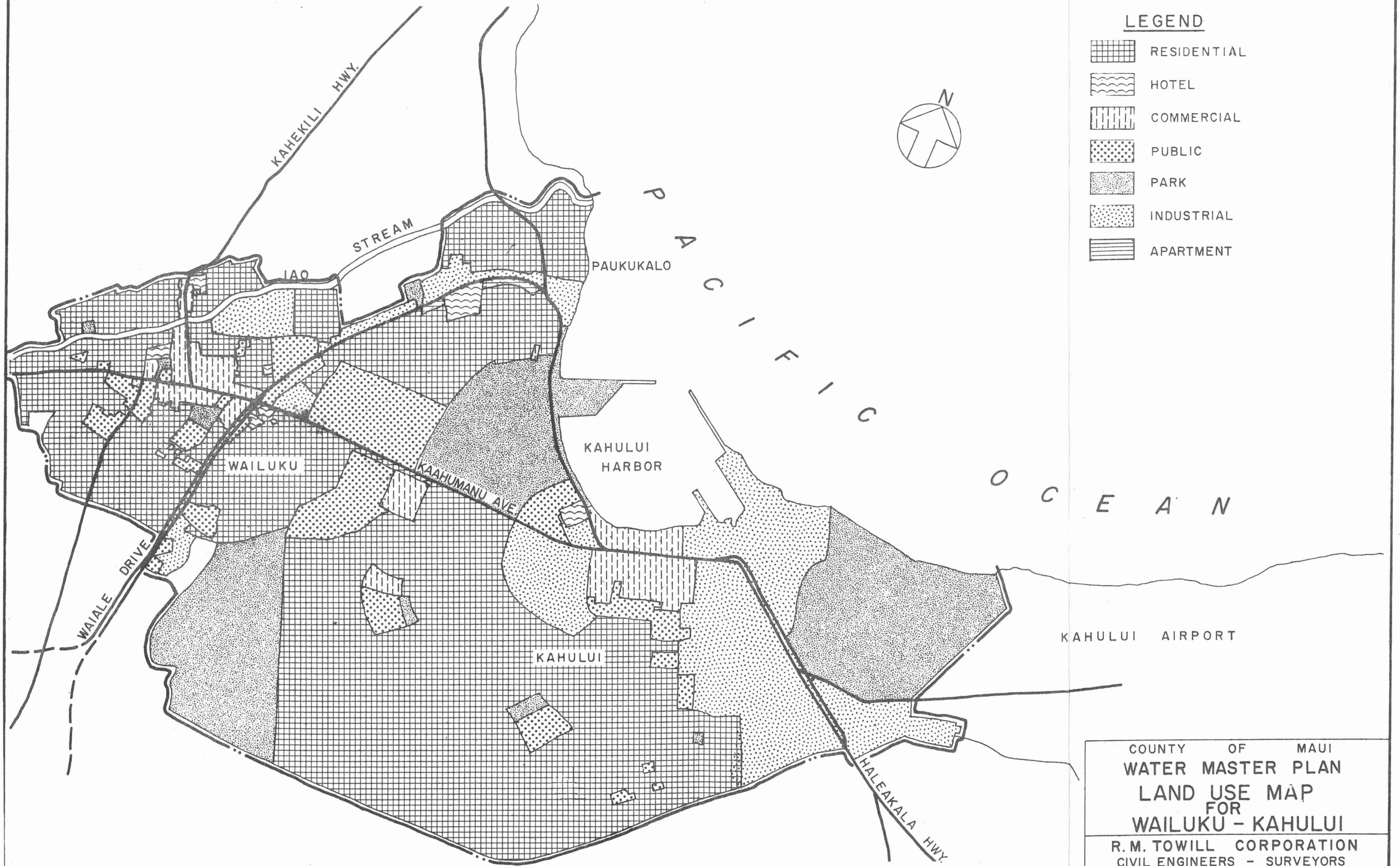
The County's General Plan for Paia is illustrated on Plate 6 with a summary of the number of acres allotted for each classification of zoning provided in Table I-3. Plate 7 outlines each individual water demand area which is further tabulated and presented in Table I-4.

TABLE NO. I-1

SUMMARY OF ZONING ACREAGE

WAILUKU-KAHULUI-PAUKUKALO

Land Use	Area in Acres
Residential	1,924.7
Hotel	19.1
Commercial	143.0
Industry	553.8
Public	242.7
School	316.3
Cemetery	6.0
Apartment	4.5



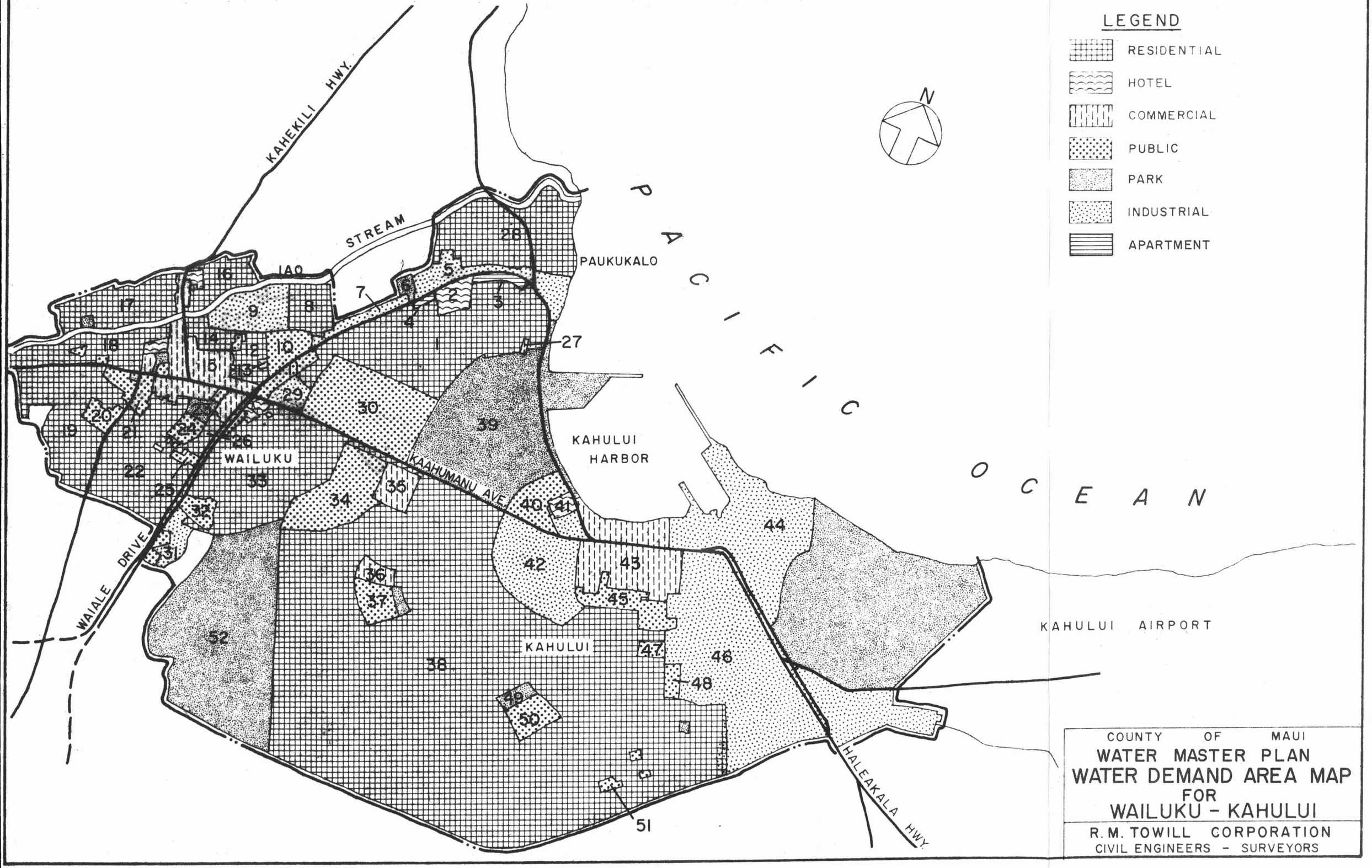
COUNTY OF MAUI

WATER MASTER PLAN

LAND USE MAP FOR WAILUKU - KAHULUI

R. M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

PLATE 4



LEGEND

- RESIDENTIAL
- HOTEL
- COMMERCIAL
- PUBLIC
- PARK
- INDUSTRIAL
- APARTMENT

COUNTY OF MAUI

WATER MASTER PLAN
WATER DEMAND AREA MAP
FOR
WAILUKU - KAHULUI

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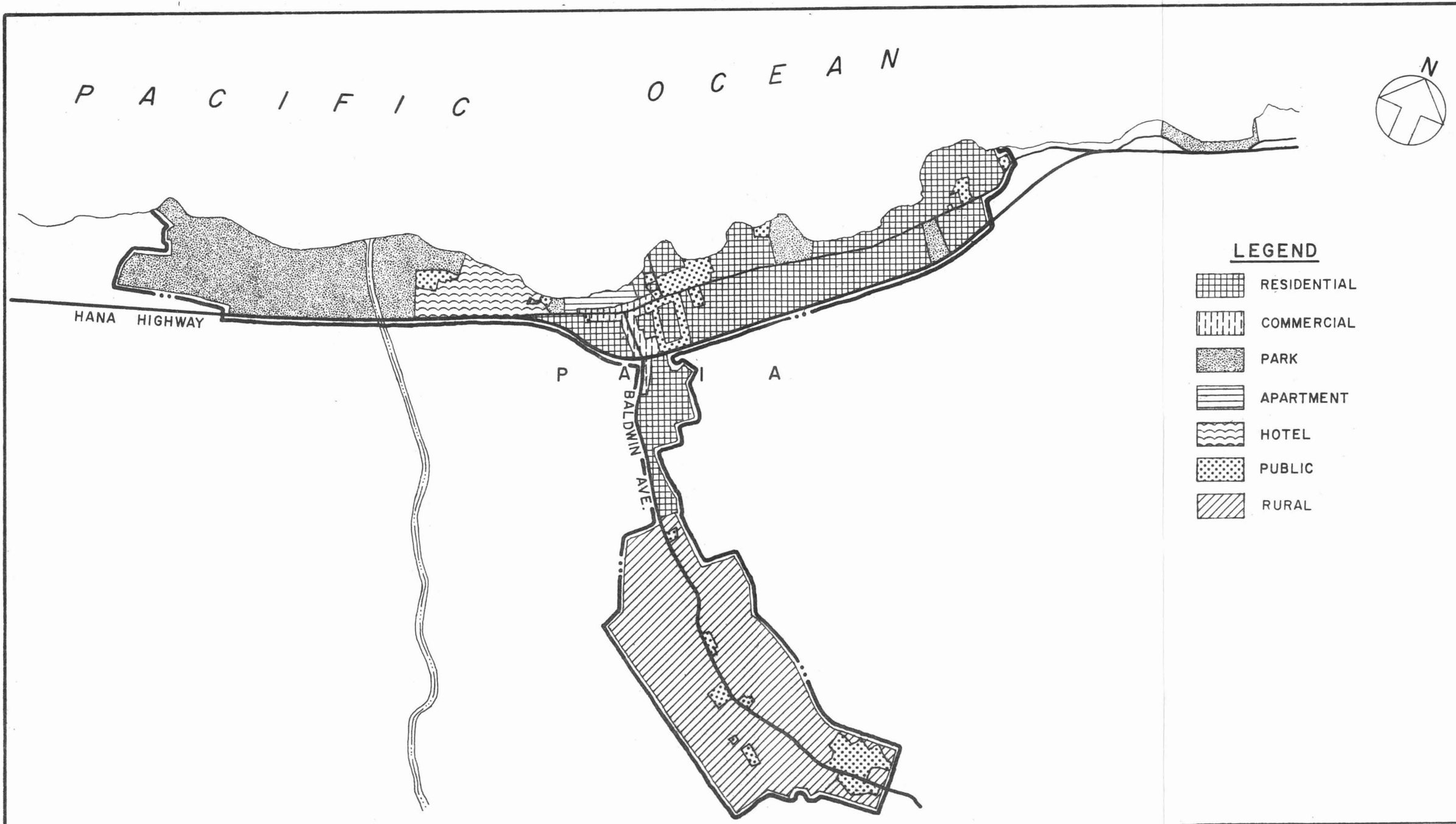
CIVIL ENGINEERS - SURVEYORS

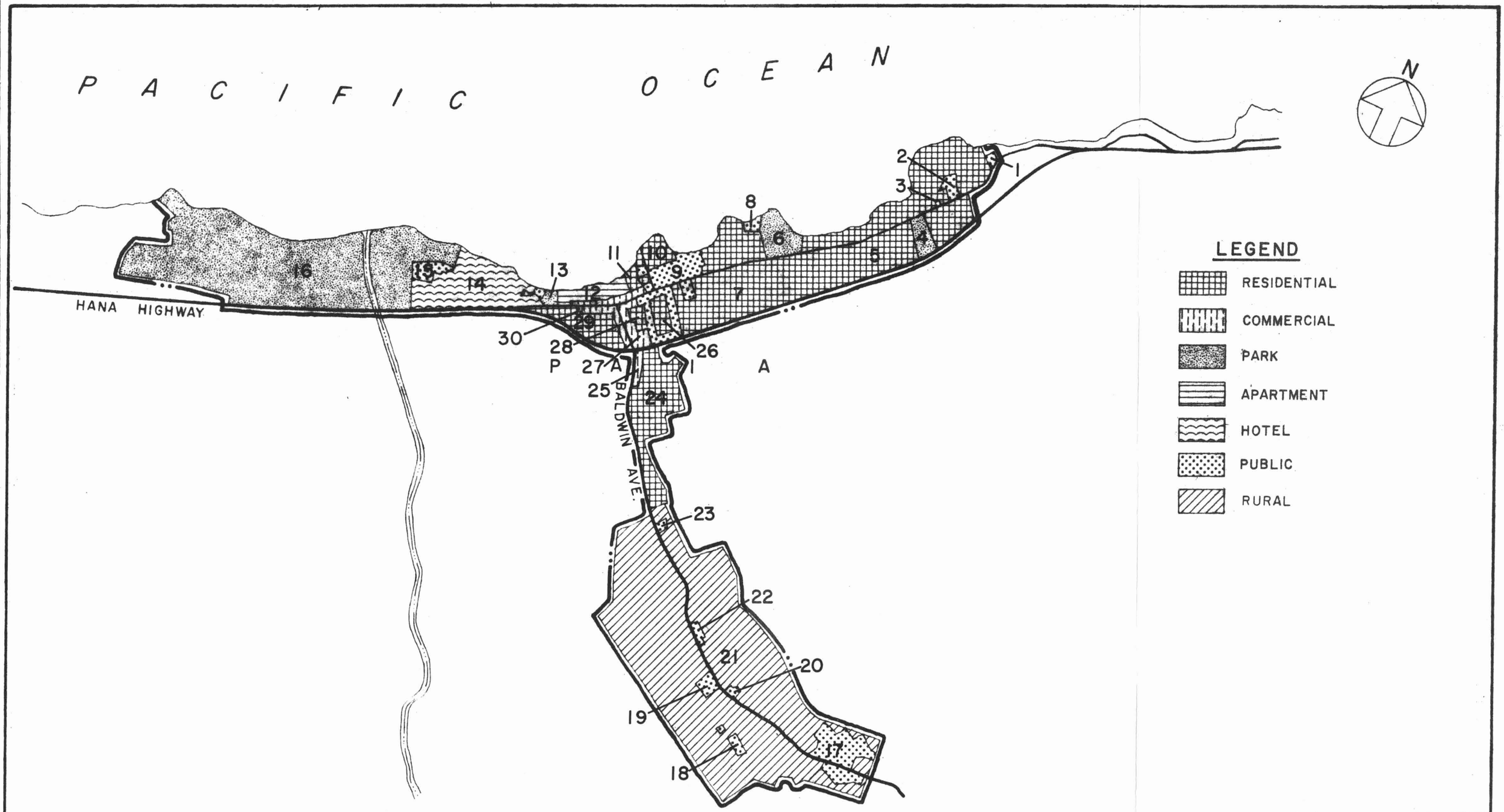
PLATE 5



COUNTY OF MAUI
WATER MASTER PLAN
LAND USE MAP
FOR
PAIA

R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS

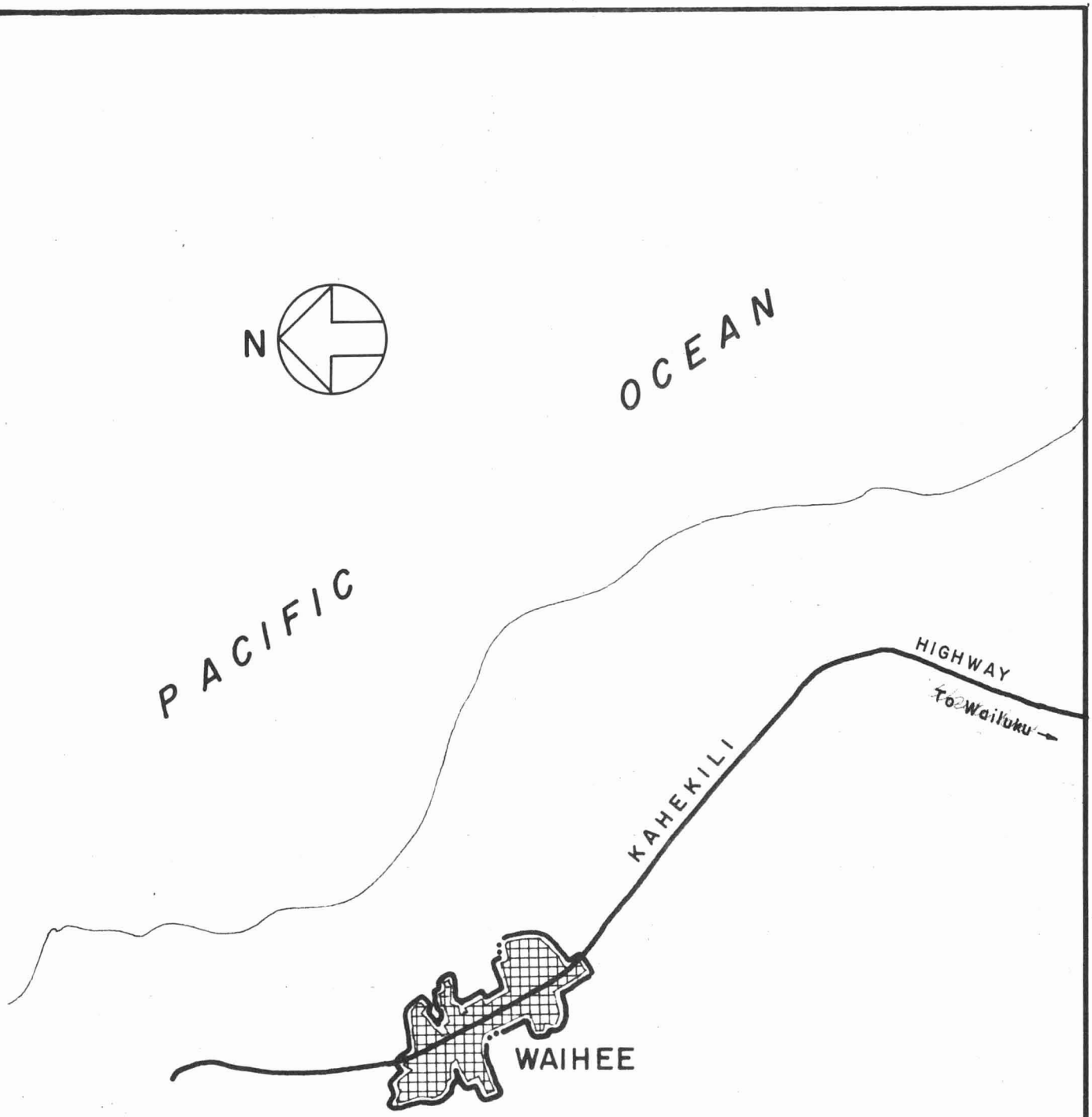
PLATE 6



COUNTY OF MAUI
WATER MASTER PLAN
WATER DEMAND AREA MAP
FOR
PAIA

R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS

PLATE 7



COUNTY OF MAUI
WATER MASTER PLAN
LAND USE MAP
FOR
WAIHEE

R.M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

PLATE 8

TABLE NO. I-2

AREA DESIGNATION/LAND USE/ACREAGE

WAILUKU-KAHULUI-PAUKUKALO

Area No.	Land Use	Acreage	Area No.	Land Use	Acreage
1	Residential	140.0	27	Residential	6.4
2	Hotel	10.5	28	Residential	48.0
3	Apartment	3.7	29	Industrial	9.4
4	Apartment	0.8	30	School	79.5
5	Industrial	34.0	31	School	4.3
6	Park	4.5	32	Industrial	12.0
7	Industrial	14.3	33	Residential	151.0
8	Residential	23.5	34	School	56.0
9	Industrial	32.6	35	Commercial	16.6
10	School	16.7	36	Commercial	4.3
11	School	10.5	37	School	12.6
12	Residential	19.6	38	Residential	1210.1
13	Hotel	0.9	39	Park	95.0
14	Residential	11.0	40	School	69.4
15	Commercial	51.6	41	Hotel	7.7
16	Residential	21.3	42	Industrial	82.5
17	Residential	43.2	43	Commercial	66.0
18	Residential	64.4	44	Industrial	118.2
19	Residential	46.6	45	School	20.0
20	School	5.3	46	Industrial	250.8
21	School	11.4	47	School	5.0
22	Residential	131.7	48	School	5.0
23	Park	4.6	49	Park	5.1
24	School	5.9	50	School	13.8
25	School	0.9	51	Cemetery	6.0
26	Residential	7.9	52	Park	133.5

TABLE NO. I-3

SUMMARY OF ZONING ACREAGE

PAIA

Land Use	Area in Acres
Residential	192.8
Cemetery	4.05
Commercial	9.3
Park	150.0
Church	12.0
Apartment	10.9
Public	0.7
Hotel	27.8
School	18.3
Gym	2.2
Rural	226.0

TABLE NO. I-4

AREA DESIGNATION/LAND USE/ACREAGE

PAIA

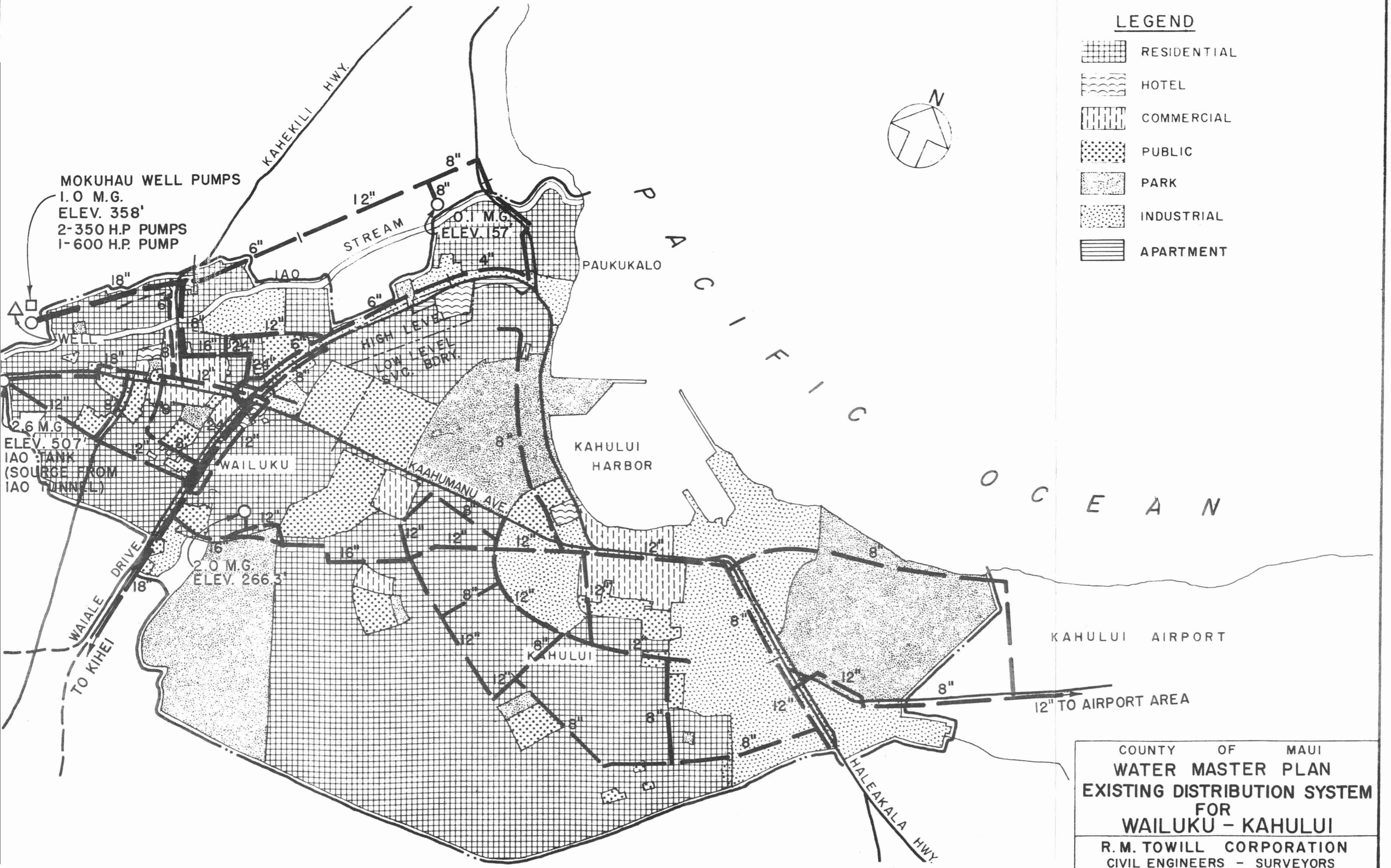
Area No.	Land Use	Acreage	Area No.	Land Use	Acreage
1	Cemetery	0.75	16	Park	140.0
2	Cemetery	1.8	17	School	14.0
3	Commercial	0.3	18	Church	1.4
4	Park	3.0	19	Church	0.3
5	Residential	88.0	20	Church	1.1
6	Park	7.0	21	Gym	2.2
7	Residential	49.6	22	Rural	226.0
8	Cemetery	1.5	23	School	0.7
9	Church	9.2	24	Residential	28.0
10	Residential	6.0	25	Commercial	1.5
11	Residential	1.5	26	Residential	5.0
12	Apartment	8.0	27	Apartment	2.9
13	Public	0.7	28	Residential	4.2
14	Hotel	27.8	29	Residential	10.5
15	School	3.6	30	Commercial	7.5

The State Land Use Classification has defined the urban (residential) area of Waihee at approximately 40 acres as shown on Plate 8.

d. Existing Facilities

The County's water system for Wailuku services three general areas: the Wailuku area; the Kahului area, including the Airport, Spreckelsville and Paia-Kuau; and the Maalaea-Kihei-Makena area. The sources of water for this system are the Mokohau wells and the Iao Tunnel. The three Mokohau wells tap the basal water underlying the Iao Valley, whereas the Iao Tunnel has high-level dike-confined ground water as a source. The withdrawal of water by Wailuku Sugar Company from the Iao Tunnel is per agreement with the County. The Board of Water Supply reserves the right to 1,073,000 gallons per day of water without charge, and an additional 1,266,100 gallons per day when needed at a base price of $55.00 per million gallons. Presently, this additional 1,266,100 gallons is not being considered as a source of water in this report.

The existing Wailuku-Kahului distribution systems are illustrated on Plate 9 and the existing distribution system for Paia-Kuau is illustrated on Plate 10. The Wailuku system is divided into a high-level and a low-level distribution system. The high-level system receives its water from the Iao Tunnel source, while the low-level system of Wailuku receives its water from the Mokohau wells.

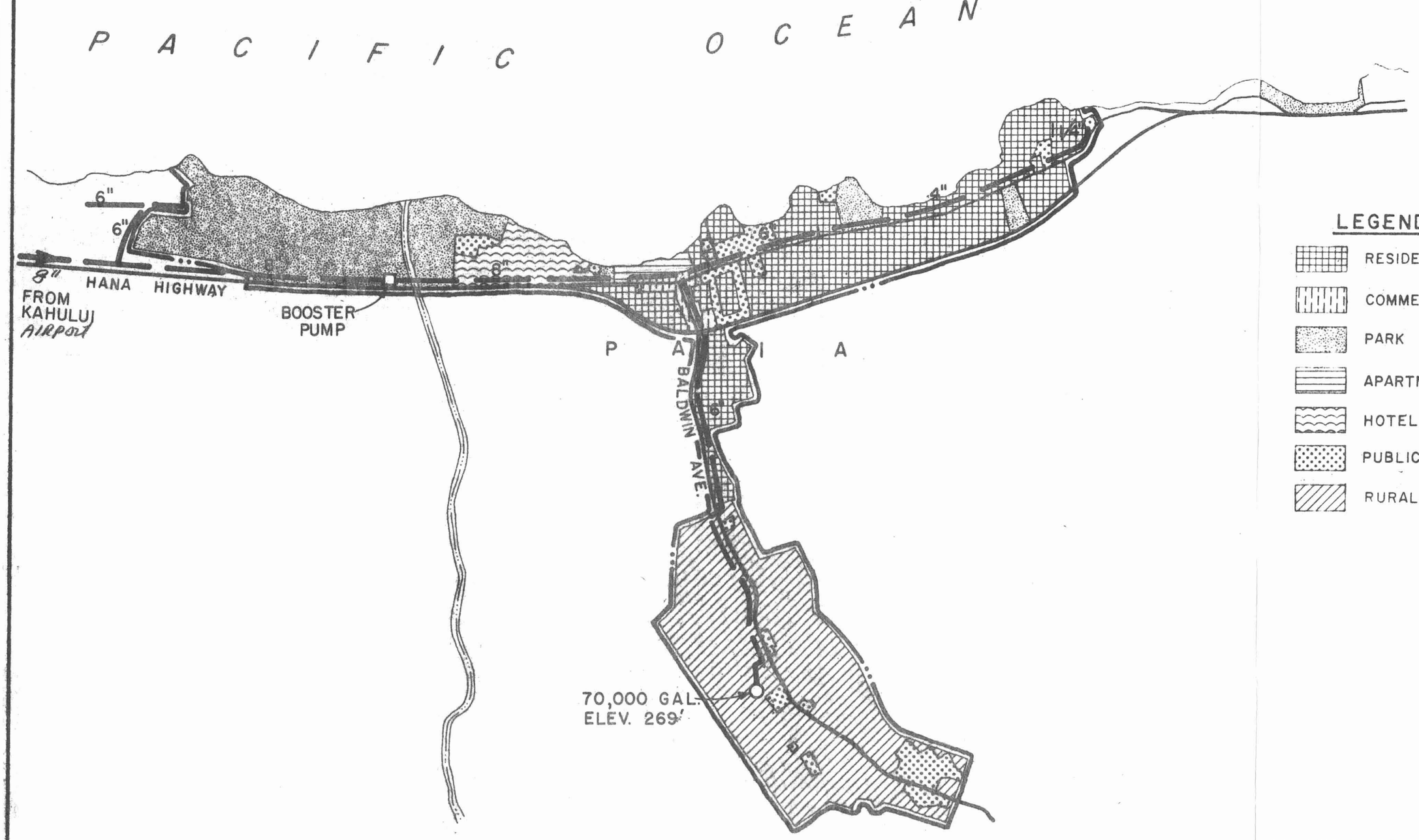


COUNTY OF MAUI

WATER MASTER PLAN
EXISTING DISTRIBUTION SYSTEM FOR WAILUKU - KAHULUI

R. M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

PLATE 9



COUNTY OF MAUI
WATER MASTER PLAN
EXISTING DISTRIBUTION SYSTEM
FOR
PAIA

R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS

PLATE 10

The figures for Wailuku-Kahului are approximately twice the flow requirements developed by the Department of Land and Natural Resources in its report "Water for Kihei-Makena".

The primary reason for the difference between water requirements projected is the method by which population projections are developed. This report considers the development of the planning area based on the County's Land Use Plan with 70% of the ultimate densities being realized for year 1980 and ultimate development (100%) provided in 1990. This report, therefore, considers population projection, but it is primarily based on a percentage of ultimate land use and water consumption on a per acre basis.

A study prepared for Alexander & Baldwin, Inc. reports a mean daily estimated water demand relatively similar to that established in this report. The Alexander & Baldwin report projected the 1990 mean daily demand for the Kahului area as 6.2 MGD. This report projects the mean daily 1990 demand for this same area at 5.9 MGD. The ultimate mean daily demand projected in the Alexander & Baldwin report is 9.0 MGD. The projection of water demand for the Alexander & Baldwin report and for this report is based on land use and water consumption on a per acre basis. In some instances, the water consumption figures for each individual land use considered in the Alexander & Baldwin report vary slightly from those used in this plan.

The Kahului system also receives its water from the Mokohau wells through the primary transmission main of the Wailuku system which feeds the Kahului reservoir. The reservoir has a capacity of two million gallons. Water from the reservoir is transmitted via a 16" main and distributed throughout the piping network of the Kahului residential area, the Airport and the Sprekelsville, Paia and Kuau areas.

Existing consumption figures for the area were developed by the Department of Land and Natural Resources in its report "Water for Kihei-Makena". An average consumption for the period June 1968 to July 1969 was listed as 1.57 million gallons per day for the Wailuku system and approximately 2.07 million gallons per day for the Kahului system.

e. Future Consumption

The estimated mean daily water demand for Wailuku-Kahului is projected in this report to be approximately 7.19 MGD for year 1980 and 10.26 MGD for 1990. The maximum water demand for this same area will approach 10.79 MGD for 1980 and 15.41 MGD for 1990. The estimated mean daily demand for the Airport, Spreckelsville and Paia-Kuau is 1.19 MGD (1980) and 2.00 MGD (1990). The maximum demands are estimated at 1.78 MGD (1980) and 3.00 MGD (1990). The consumption rates for the individual systems are tabulated in Table I-5, I-6 and I-7.

TABLE NO. I-5

ADOPTED DESIGN CRITERIA
FOR
WAILUKI-KAHULUI-PAUKUKALO

Area	Land Use	Pop. Per Acre	Flow GPCD	Flow GPAD	1980 70% of Max Development Acres	1980 70% of Max Development Population	1980 70% of Max Development Flow Mean Daily	1990 100% of Max Development Acres	1990 100% of Max Development Population	1990 100% of Max Development Flow	Max Development (2,000) Acres	Max Development (2,000) Population	Max Development (2,000) Flow
	Residential	18	140	2,500	1,347.0	24,246	3.3675	1,924.7	34,644	4.8118	-	-	-
	Apartment	40	140	5,600	3.2	128	0.0179	4.5	180	0.0252	-	-	-
	Commercial	-	-	6,000	98.0	-	0.5880	138.5	-	0.8310	-	-	-
	Industrial	-	-	6,000	387.7	-	2.3262	553.8	-	3.3228	-	-	-
	Public	-	-	1,700	170.0	-	0.2890	242.7	-	0.4126	-	-	-
	School	-	-	1,700	221.4	-	0.3764	316.3	-	0.5377	-	-	-
	Hotel	-	-	17,000	13.3	-	0.2261	19.0	-	0.3230	-	-	-
	Cemetery	-	-	-	-	-	-	6.0	-	-	-	-	-
	SUM	-	-	-	2,240.6	24,374	7.1911	3,205.5	34,824	10.2641	-	-	-

PAIA

					1980 35% of Max Development			1990 70% of Max Development			Max Development (2,000)		
	Residential	17	140	2,400	67.5	1,147	0.1620	135.0	2,295	0.3240	192.8	3,278	0.4627
	Apartment	40	140	5,600	3.8	153	0.0213	7.6	306	0.0426	10.9	436	0.0610
	Hotel	-	-	17,000	9.7	-	0.1649	19.4	-	0.3298	27.8	-	0.4726
	Commercial	-	-	6,000	3.3	-	0.0198	6.6	-	0.0396	9.3	-	0.0558
	Rural	5	-	1,800	79.1	198	0.1424	158.2	396	0.2848	226.0	565	0.4068
	Public	-	-	1,700	11.6	-	0.0197	23.2	-	0.0394	33.2	-	0.0564
	SUB TOTAL	-	-	-	-	1,498	0.5301	-	2,997	1.0602	-	4,279	1.5153

TABLE NO. I-6
ADOPTED DESIGN CRITERIA
FOR
WAILUKU-KAHULUI

Area	Land Use	Per Acre	GPCD	GPAD	1980 70% of Max Development Acres	1980 70% of Max Development Population	1980 70% of Max Development Flow	1990 100% of Max Development Acres	1990 100% of Max Development Population	1990 100% of Max Development Flow	Max Development (2,000) Acres	Max Development (2,000) Population	Max Development (2,000) Flow
#11, #14,	Residential	18	140	2,500	213.4	3,840	0.5334	304.8	5,486	0.762		N/A	
#15, #17,	Public	-	-	1,700	27.0	-	0.0459	38.6	-	0.0656			
& #26	Commercial	-	-	6,000	36.1	-	0.2167	51.6	-	0.3096			
1/2 of #1,	Residential	18	140	2,500	199.8	3,596	0.4995	285.4	5,137	0.7135			
#2, # 4,	Apartment	40	140	5,600	0.6	22	0.0031	0.8	36	0.00448			
#8-10, #12	Public	-	-	1,700	14.7	-	0.0250	21.0	-	0.0357			
#13, #16,	Hotel	-	-	17,000	8.0	-	0.1357	11.4	-	0.1938			
#29, #31-33	Industrial	-	-	6,000	37.8	-	0.2268	54.0	-	0.3240			
1/2 of #1,	Residential	18	140	2,500	87.1	1,567	0.2177	124.4	2,239	0.3110			
#3, #5-7,	Apartment	40	140	5,600	2.6	104	0.0145	3.7	148	0.02072			
#27, #28,	Industrial	-	-	6,000	33.8	-	0.2029	48.3	-	0.2898			
#30, #39-41	Hotel	-	-	17,000	5.4	-	0.0916	7.7	-	0.1309			
	Public	-	-	1,700	173.9	-	0.2956	248.4	-	0.4223			
#34-#38,	Residential	18	140	2,500	847.1	15,247	2.1177	1210.1	21,782	3.0253			
#42-#52	Commercial	-	-	6,000	60.8	-	0.3650	86.9	-	0.5214			
	Public	-	-	1,700	179.9	-	0.3058	257.0	-	0.4369			
	Industrial	-	-	6,000	316.1	-	1.8960	451.5	-	2.7090			
	TOTAL	-	-	-	2244.1	24,376	7.1929	3205.6	34,824	10.2760			

TABLE NO. I-7

CONSUMPTION RATES
FOR
INDIVIDUAL SYSTEMS

AREA	POPULATION		ESTIMATED WATER DEMAND									STORAGE			
			Mean Daily		Max Day		Peak Hourly		Fire Flow		1990 Duration	Fire Flow		Peak Flow	
	1980	1990	1980	1990	1980	1990	1980	1990	1980	1990	Hours	Req'd	Exist.	Req'd	New
Wailuku (1)	3,840	5,486	0.7960	1.1372	1.1940	1.70587	2.3880	3.4116	1,980	2,380	10	1.43	2.6	0.86	-
Wailuku (2)	3,618	5,169	0.8901	1.2715	1.3352	1.9073	2.6703	3.8145	1,930	2,300	10	1.38	1.0	0.83	1.0
Wailuku (3)	1,671	2,387	0.8223	1.1747	1.2335	1.7621	2.4669	3.5241	1,340	1.600	6	0.58	0.1	0.58	1.5
SUBTOTAL	9,129	13,042	2.5084	3.5834	3.7626	5.3751	7.5252	10.7502	3,910	6,280	-	3.39	3.7	2.27	2.5
Kahului (4)	15,247	21,782	4.6845	6.6926	7.0268	10.0389	14.0535	20.0778	3,800	4,500	10	2.70	2.0	1.62	5.0
SUBTOTAL (1-4)	24,376	34,824	7.1929	10.2760	10.7894	15.4140	21.5787	30.8280	7,710	10,780	-	6.09	5.7	3.89	7.5
Paia	1,498	2,997	0.530	1.060	0.795	1.590	1.590	3.180	1,250	1,750	7	0.74	0.070	0.79	1.5
Spreckles-ville	1,414	2,014	0.198	0.282	0.297	0.423	0.594	0.846	1,100	1,500	6	0.54	-	0.54	-
Naska	15,342*	21,918*	0.460	0.658	0.690	0.987	1.380	1.974	2,000	2,000	8	0.96	-	0.72	-
SUBTOTAL	18,254	26,929	1.188	2.000	1.782	3.000	3.564	6.000	4,350	5,250	-	2.24	-	1.26	-
GRAND TOTAL	42,630	61,753	8.3809	12.276	12.5714	18.4140	25.1427	36.8280	12,060	16,030	51	8.33	-	5.15	-

NOTE: Mean Daily, Max Daily and Peak Hourly Flows in MGD; Fire Flow in GPM.

*Passenger Per Day; Flow at 30 GPCD

NOTE: (1) Areas 11, 14, 15, 17 to 26
(2) Areas 1/2 of 1, 2, 4, 8, 9, 10, 12, 13, 16, 29, 31, 32, 33
(3) Areas 1/2 of 1, 3, 5, 6, 7, 27, 28, 30, 39 to 41
(4) Areas 34 to 38, 42 to 52

f. Source

The existing Mokohau well system has a drawing capacity of eight million gallons per day. The volume of water capable of being drawn is limited by the electrical capacity of the step-down transformers required to operate the pumps. The Mokohau wells are capable of drawing a maximum of ten million gallons per day should additional facilities be incorporated in the electrical system to provide for the increased capacity required. The report entitled "Water for Kihei-Makena" has indicated that high-level ground water in Iao Valley might possibly be a future source of additional water for the Wailuku-Kahului area. This water could be carried through the existing transmission system of Iao Tunnel. This report lists other sources at Happy Valley and at Waihee with yield at Waihee expected to be plentiful.

Presently, water for the Kihei area is drawn from the Wailuku Source. It is intended that the final development plan for the Kihei area incorporate the development of the Waikapu wells as the water source for servicing the Kihei study area. Should this intended source not materialize, then the source at Happy Valley would be required to be further developed and a program for this improvement is proposed to be undertaken when and if the necessity arises.

g. Proposed Development

The proposed Water Master Plan for the study area is shown schematically on Plates 11 and 12 with the development plans illustrated on Plates 13 and 14. In order to provide for the projected water demand of this area of study and the area anticipated

growth rate, the development of the water system is proposed to be carried out in the following stages:

(1) Stage I

The development of the system in this phase includes:

(a) Improving the electrical system to increase the capabilities of the Mokohau wells to 10.0 MGD:

(b) Installation of approximately 1,200 feet of 20" pipeline to parallel the existing 16" pipeline along North Market Street;

(c) Installation of approximately 5,000 linear feet of 12" pipeline along lower Main Street; and

(d) Installation of approximately 3,000 linear feet of 12" pipeline along Piihana Street.

(2) Stage II

The second stage includes:

(a) Installation of 4,000 linear feet of 8" pipeline along Liholiho Street.

(b) The installation of 2,000 linear feet of 16" pipeline from the 24" transmission main to the proposed 3.0 MG storage tank at Kahului.

(c) The development of a 3.0 MG storage tank and installation of approximately 15,000 linear feet of 18" pipeline at Kahului; and

(d) The installation of 4,900 linear feet of 18" pipeline from Mokohau wells to North Market Street.

(3) Stage III

This stage includes:

(a) The development of a 2.0 MG well at Kapaniwai;

(b) The development of a 2.0 MG storage tank at Kahului;

(c) The installation of approximately 18,000 linear feet of 12" pipeline and 9,000 linear feet of 16" pipeline at Kahului;

(d) The development of a 1.0 MG storage tank at Mokohau wells and a 2.0 MG well at Happy Valley;

(e) The installation of approximately 15,000 linear feet of 12" pipeline from the Happy Valley wells to Wailuku; and

(f) The development of a 1.5 MG storage tank at lower Wailuku.

(g) The installation of approximately 5,000 linear feet of 12" pipeline parallel to Kahului Beach Road; approximately 5,000 linear feet along Kanaloa Avenue; and 6,000 linear feet along Kaahumanu Avenue.

The proposed development of the Paia area includes the Airport, Spreckelsville, Paia and Kuau.

(1) Stage I

This stage includes approximately 2,000 linear feet of 12" pipeline along Hana Highway and Paia and 9,000 linear feet of 8" pipeline along Hana Highway from Paia to Kuau.

(2) Stage II

This stage includes approximately 8,000 linear feet of

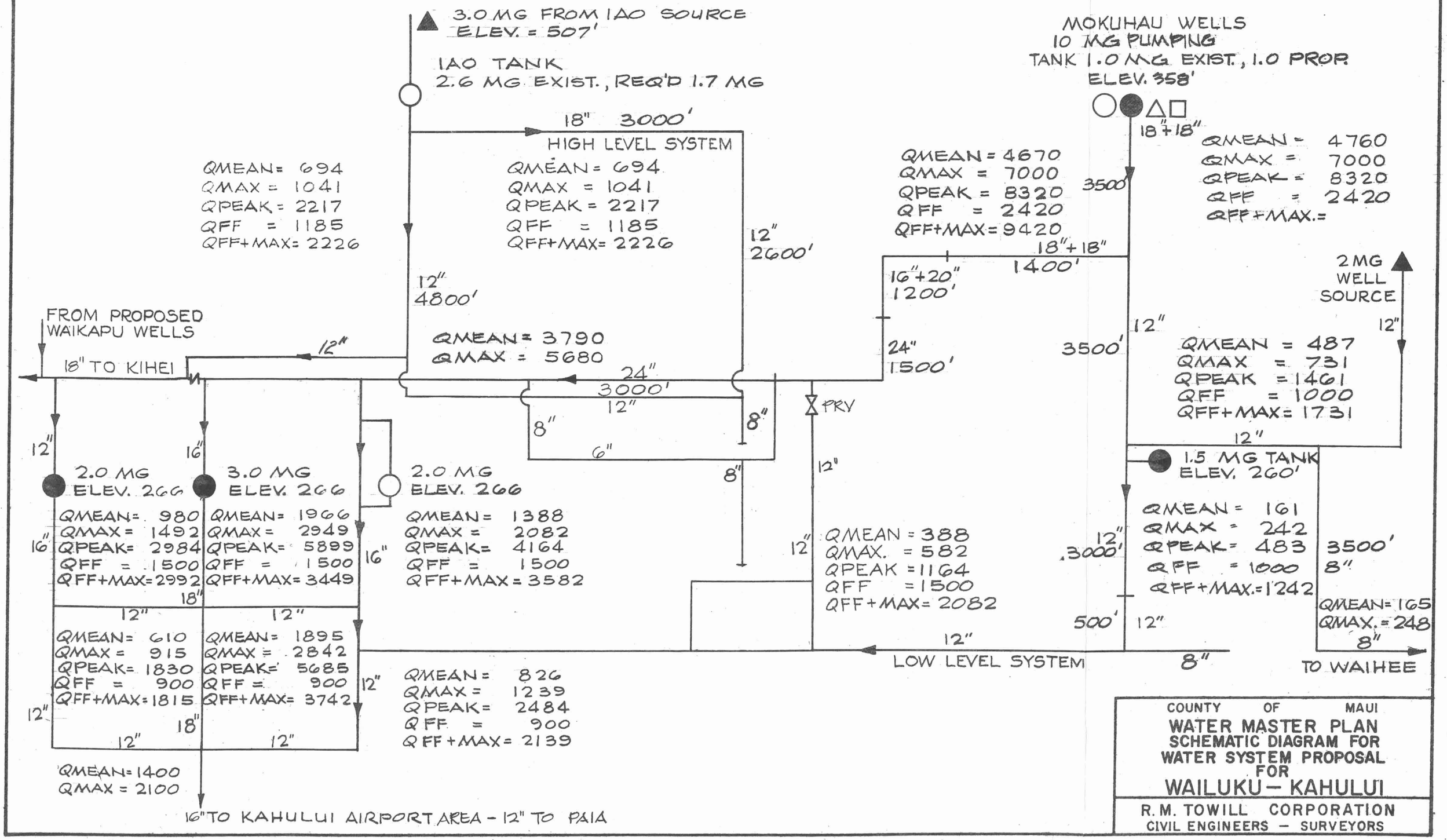
12" pipeline along Baldwin Highway at Paia, a 1.0 MG storage tank in Paia and approximately 14,000 linear feet of 16" pipeline from Kahului to the Airport Area and 15,500 linear feet of 12" pipeline along Hana Highway from the Airport to Paia.

(3) Stage III

The last phase of the Paia development includes a 0.5 MG pumping station, approximately 5,500 linear feet of 12" pipeline along Baldwin Highway leading to upper Paia and a 0.5 MG storage tank at upper Paia.

Waihee Water Plan

The proposed water plan for the Waihee area includes the development of a 0.25 MG storage tank at an approximate elevation of 250 feet and the installation of 1,000 linear feet of 12" pipeline from the 8" transmission main to this 0.25 MG storage tank.

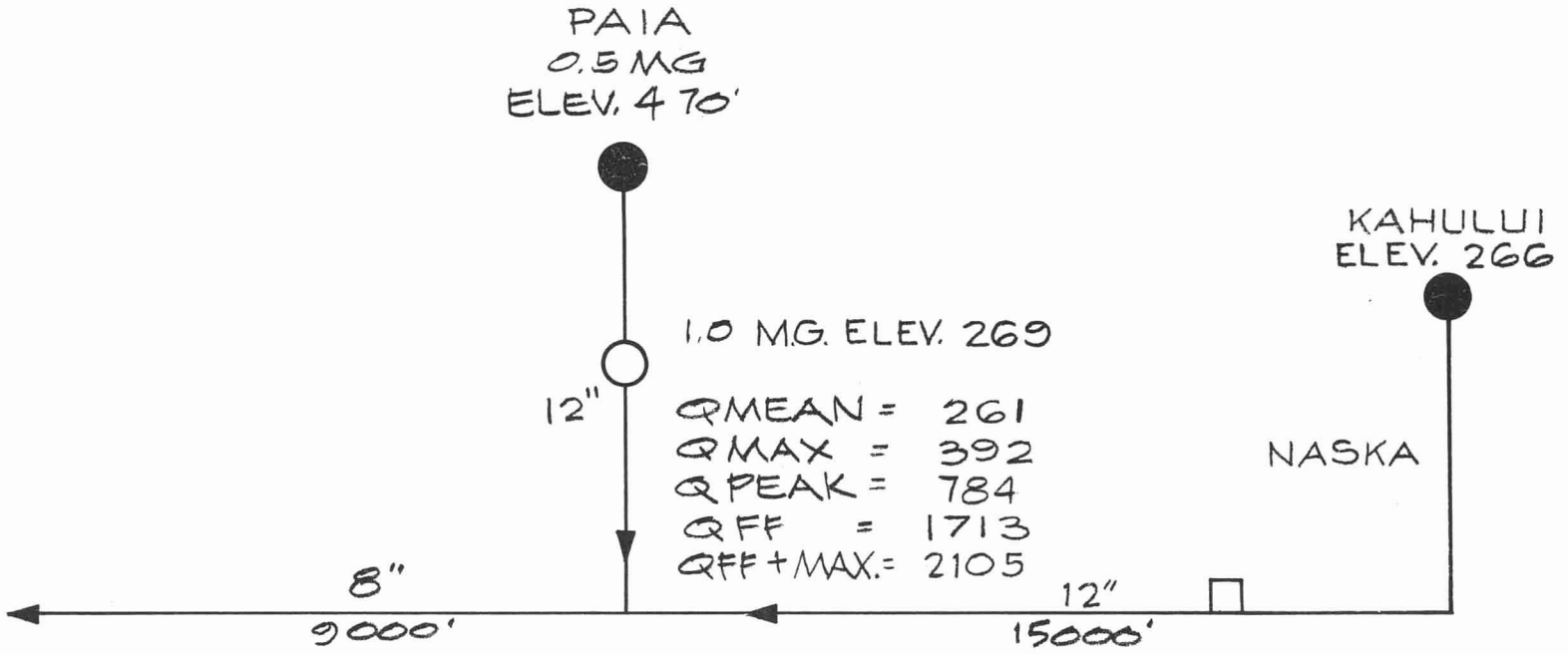


COUNTY OF MAUI

WATER MASTER PLAN
SCHEMATIC DIAGRAM FOR
WATER SYSTEM PROPOSAL
FOR
WAILUKU – KAHULUI

R. M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE II



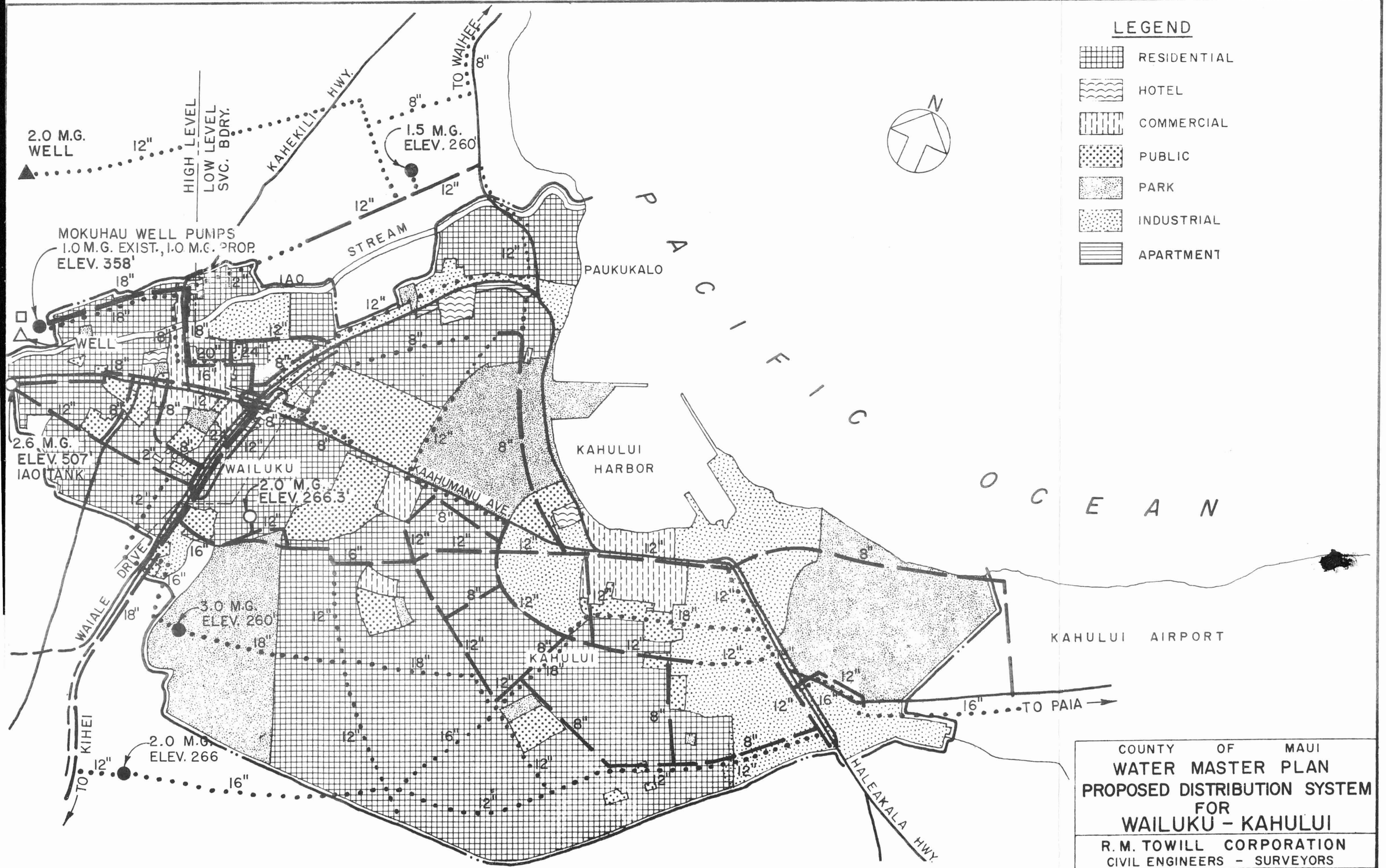
NOTE: FLOWS IN GPM

COUNTY OF MAUI

WATER MASTER PLAN
SCHEMATIC DIAGRAM FOR
WATER SYSTEM PROPOSAL
FOR
PAIA

R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS

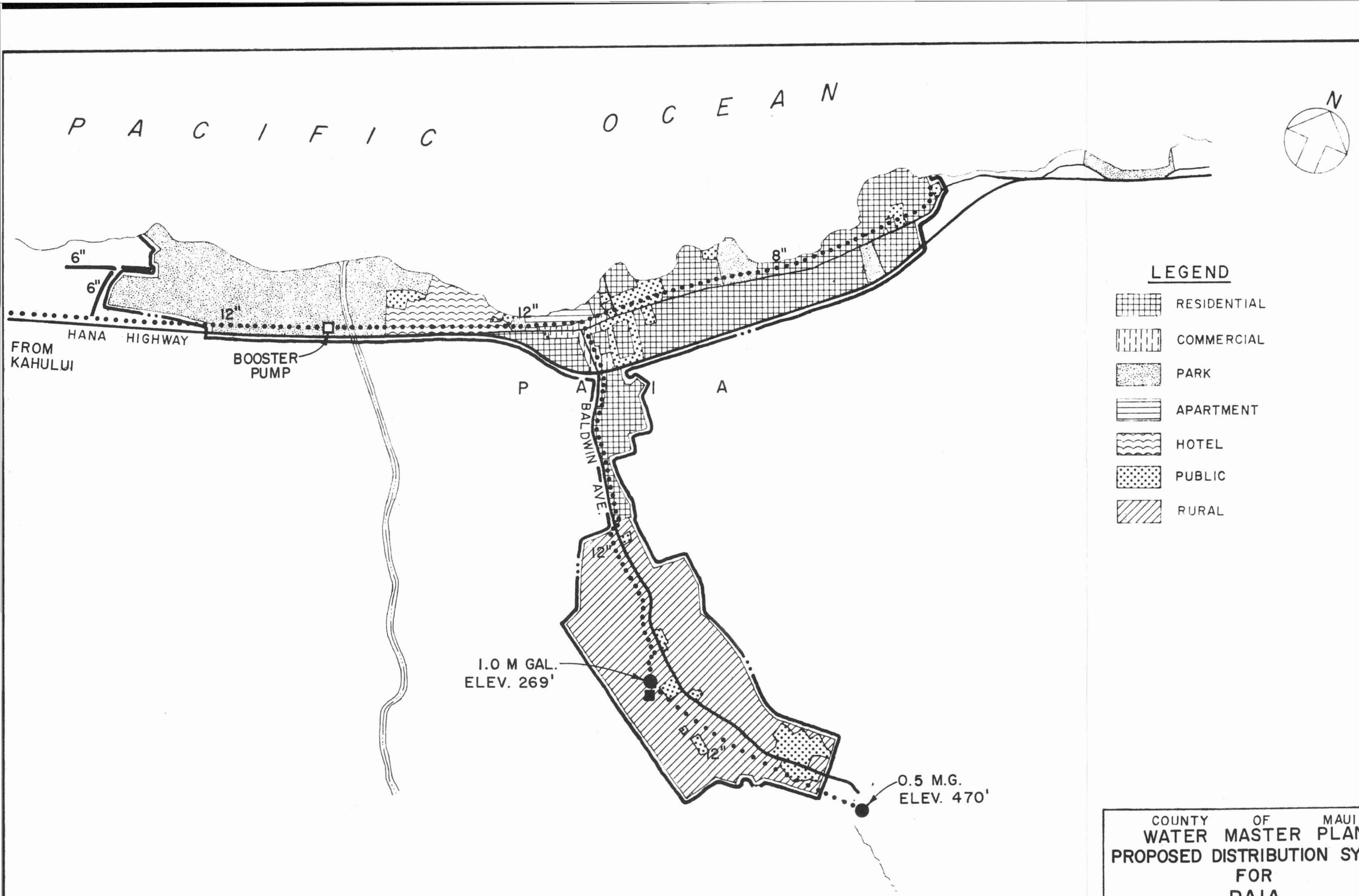
PLATE 12



COUNTY OF MAUI
WATER MASTER PLAN
PROPOSED DISTRIBUTION SYSTEM
FOR
WAILUKU - KAHULUI

R. M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

PLATE 13



COUNTY OF MAUI
WATER MASTER PLAN
PROPOSED DISTRIBUTION SYSTEM
FOR
PAIA

R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS

PLATE 14

2. Lahaina-Kaanapali-Napili

a. Limits of Study

The Lahaina-Kaanapali-Napili study area, located on the southwest shoreline of the island, encompasses some 3,000 acres of land between the south side of Honokahau Stream and the north side of Kauaula Stream. The limits of study for this area are illustrated on Plate 15.

b. Economic Conditions

Historically, the sugar and pineapple industries have provided the bulk of employment opportunities within the Lahaina-Kaanapali-Napili study area. Today, however, the unusual charm of Lahaina Town and the development of the Kaanapali resort complex have advanced the visitor industry to a position of growth which may soon make it the area's primary employer. This increase in the tourist industry and resort-hotel personnel has emphasized the need for additional housing. Construction activities are in evidence throughout the study area to provide this housing. The Lahaina Shopping Center and the commercial area now being developed in Kaanapali will further escalate employment. The continued economic growth outlook for the area is optimistic.

c. Land Use and Water Demand Area

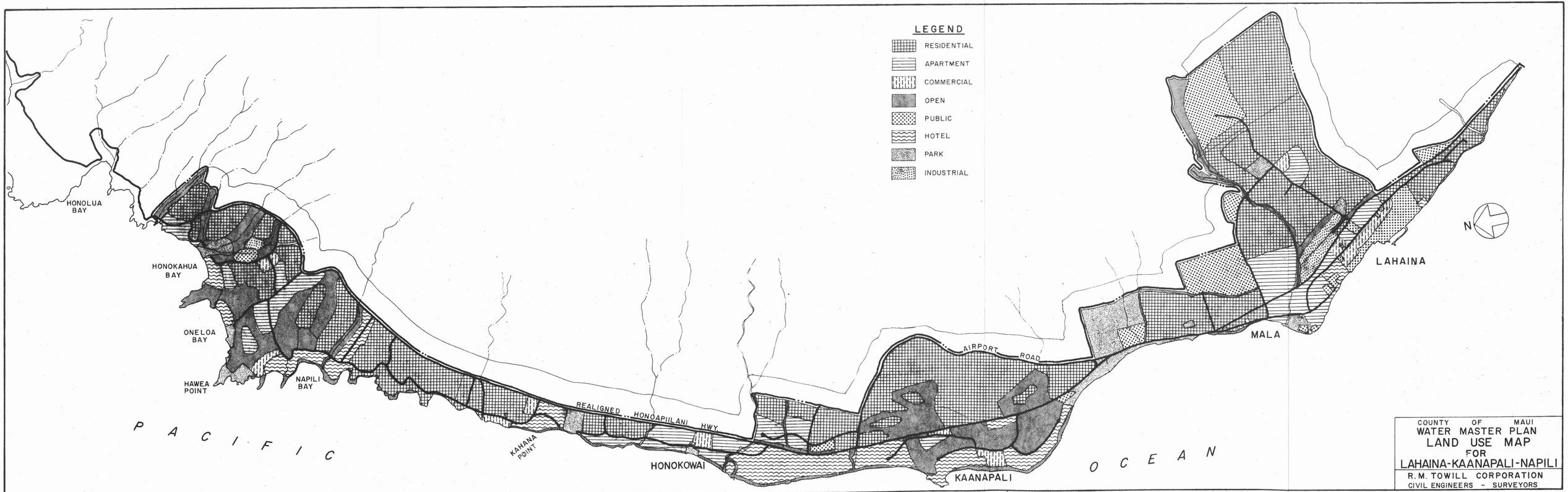
The County's General Plan for development of this study area is illustrated on the Land Use Map, Plate 15 of this report. Table I-8 summarizes the number of acres allotted for each type of zoning classification. The water demand areas for this area of study is illustrated on Plate 16 and listed in tabular form on Table I-9 of this report.

TABLE NO. I-8

SUMMARY OF ZONING ACREAGE

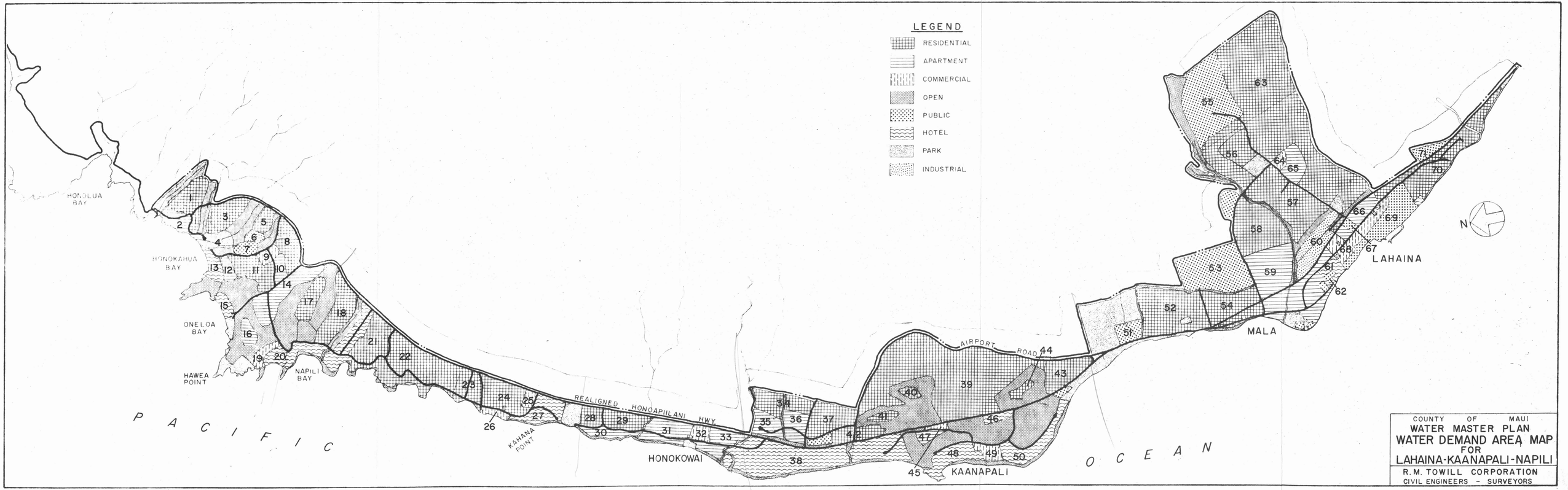
LAHAINA-KAANAPALI-NAPILI

Land Use	Area in Acres
Residential	2103.5
Apartment	504.6
Park	21.0
Industry	92.0
Public	12.8
Commercial	98.6
Hotel	510.6
Civic Center	18.0
School	235.0
Church	18.8
Civil	76.4
Cemetery	11.2



COUNTY OF MAUI
WATER MASTER PLAN
LAND USE MAP
FOR
LAHAINA-KAANAPALI-NAPILI
R. M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

PLATE 15



COUNTY OF MAUI
WATER MASTER PLAN
WATER DEMAND AREA MAP
FOR
LAHAINA-KAANAPALI-NAPILI

R. M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

PLATE 16

TABLE NO. I-9

AREA DESIGNATION/LAND USE/ACREAGE

LAHAINA-KAANAPALI-NAPILI

Area No.	Land Use	Acreage	Area No.	Land Use	Acreage
1	Residential	57.0	37	Residential	116.0
2	Apartment	18.4	38	Hotel	212.0
3	Residential	37.7	39	Residential	341.8
4	Park	21.0	40	Residential	9.2
5	Residential	18.4	41	Residential	9.2
6	Industrial	10.8	42	Residential	24.0
7	Public	12.8	43	Residential	47.8
8	Residential	27.6	44	Residential	9.2
9	Commercial	10.0	45	Commercial	9.2
10	Apartment	13.0	46	Hotel	12.9
11	Residential	43.2	47	Apartment	11.0
12	Apartment	9.2	48	Hotel	47.8
13	Hotel	21.4	49	Commercial	16.5
14	Apartment	56.0	50	Hotel	55.1
15	Hotel	10.8	51	Civic Center	18.0
16	Apartment	9.2	52	Residential	100.0
17	Residential	23.0	53	School	105.0
18	Residential	55.0	54	Residential	57.0
19	Commercial	11.2	55	School	130.0
20	Hotel	99.2	56	Residential	81.5
21	Residential	65.2	57	Residential	110.0
22	Residential	130.0	58	Residential	85.5
23	Residential	30.0	59	Apartment	100.0
24	Residential	64.3	60	Industrial	81.2
25	Commercial	10.4	61	Hotel	12.6
26	Apartment	6.5	62	Church	3.4
27	Hotel	37.0	63	Residential	410.0
28	Residential	18.4	64	Commercial	7.3
29	Residential	32.0	65	Apartment	37.0
30	Apartment	36.8	66	Apartment	15.6
31	Apartment	60.8	67	Church	15.4
32	Commercial	12.0	68	Commercial	22.0
33	Apartment	40.2	69	Civil	76.4
34	Residential	35.0	70	Residential	65.5
35	Apartment	25.7	71	Cemetery	11.2
36	Apartment	65.2	72	Hotel	1.8

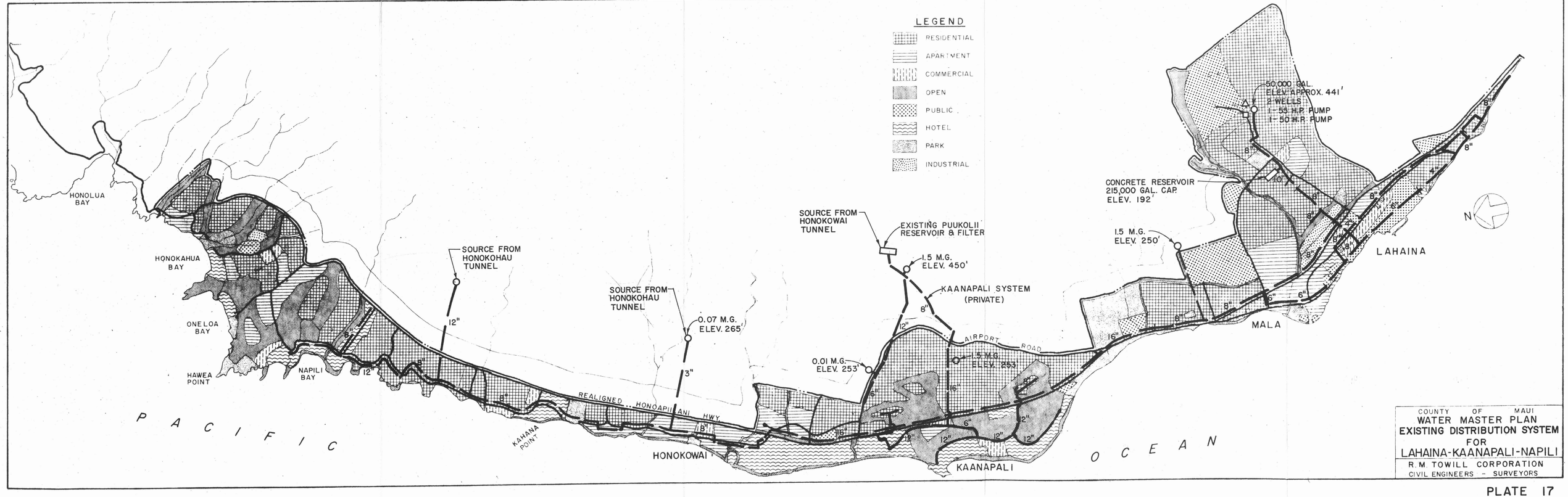
d. Existing Facilities

Domestic water is supplied from four different systems in the Lahaina district. These four systems, Lahaina Town, Kaanapali, Alaeloa-Kahana and Honokahua are illustrated on Plate 17.

The Lahaina Town system has as its source the upper region of Kahana Stream and a basal water well near Lahainaluna School. The water from the Kahana Stream is shared by the County, Lahainaluna School and Pioneer Mill Company. The County presently has rights to 0.5 MGD of water from the Kahana stream source. This, plus the approximate 0.4 MGD from the wells, provide a total safe yield of approximately 0.9 MGD.

The Kaanapali system is privately owned and supplies domestic water for the Kaanapali resort area. The source of water for the Kaanapali system is the Honokowai Tunnel which recieves its water from the Honokowai Stream at an approximate elevation of 1580 feet. The Kaanapali source (Honokowai Tunnel) is capable of delivering about twenty million gallons of water per day.

Alaeloa-Kahana and Honokohau are County-owned systems. Under an agreement with Baldwin Packers (now Maui Land and Pineapple Co.) the two systems will utilize Honokohau Tunnel as a source until the lease agreement expiration date of January 1, 1974. The continued use of this source, however, is dependent upon field investigations scheduled to be conducted by the State of Hawaii, Department of Land and Natural Resources, Division of Water and Land Development, to determine the availability of basal water as a source of supply.



COUNTY OF MAUI
WATER MASTER PLAN
EXISTING DISTRIBUTION SYSTEM
FOR
LAHAINA-KAANAPALI-NAPILI
R.M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

PLATE 17

Distribution lines for the County systems, except for the 16" transmission line from Mala to Honokowai, are generally inadequate in size to handle the expected flow requirements of 1990. Storage is also inadequate at the present time and provides little margin for community growth and insufficient capacity for fire protection.

A report prepared for the Department of Land and Natural Resources estimates the present domestic water consumed in the Lahaina District to be approximately two million gallons per day. The bulk of the consumption is utilized by the Lahaina Town and Kaanapali systems. Lahaina Town has an average consumption rate of approximately 600,000 gallons per day, while Kaanapali has an average consumption rate of approximately 1.2 million gallons per day. The remainder is distributed throughout the district.

e. Future Consumption

The average daily consumption for this study area is expected to increase to about 6 million gallons per day in 1980 and to 12 million gallons per day by 1990. These figures include the project water requirements of the Kaanapali System. These projected consumption rates are developed as outlined in Table I-10 through I-14 and are in general agreement with those given in the Department of Land and Natural Resources report, "A Water Plan for the Lahaina District".

TABLE NO. I-10

ADOPTED DESIGN CRITERIA
FOR
LAHAINA-KAANAPALI-NAPILI

Area	Land Use	Per Acre	GPCD	GPAC	1980 35% of Max Development			1990 70% of Max Development			Max Development (2,000)		
					Acres	Population	Flow	Acres	Population	Flow	Acres	Population	Flow
	Residential	13	140	1,800	736.2	9,570	1.3252	1,472.4	19,140	2.6503	2,103.5	27,345	3.7863
	Apartment	40	140	5,600	176.6	7,064	0.9889	353.2	14,128	1.9779	504.6	20,184	2.8258
	Commercial	-	-	6,000	34.5	-	0.2070	69.0	-	0.4140	98.6	-	0.5916
	Industrial	-	-	6,000	32.2	-	0.1932	64.4	-	0.3864	92.0	-	0.5520
	Civic & Sch	-	-	1,700	126.4	-	0.2149	252.8	-	0.4298	361.0	-	0.6137
	Hotel	-	-	17,000	178.1	-	3.0379	357.4	-	6.0758	510.6	-	8.6802
	SUM	-	-	-	-	16,634	5.9671	-	33,268	11.9342	-	47,529	17.0496

TABLE NO. I-11

ADOPTED DESIGN CRITERIA
FOR
NAPILI-KAANAPALI-LAHAINA

Area	Land Use	Per Acre	GPCD	GPAD	1980 % of Max Development Acres	1980 % of Max Development Population	1980 % of Max Development Flow	1990 % of Max Development Acres	1990 % of Max Development Population	1990 % of Max Development Flow	Max Development (2,000) Acres	Max Development (2,000) Population	Max Development (2,000) Flow
# 1 to #10	Residential	13	140	1,800	49.3	641	0.0887	98.5	1,281	0.1773	140.7	1,829	0.2533
	Apartment	40	140	5,600	11.0	440	0.0616	22.0	880	0.1232	31.4	1,256	0.1758
	Commercial	-	-	6,000	3.5	-	0.0210	7.0	-	0.0420	10.0	-	0.0600
	Industrial	-	-	6,000	3.8	-	0.0228	7.5	-	0.0450	10.7	-	0.0642
	Public	-	-	1,700	11.7	00	0.0201	23.7	-	0.0403	33.8	-	0.0575
	SUB TOTAL	-	-	-	79.3	1,081	0.2142	158.7	2,161	0.4278	226.6	3,085	0.6108
#11 to #17	Residential	13	140	1,800	23.2	302	0.0418	46.3	603	0.0833	66.2	861	0.1192
	Apartment	40	140	5,600	26.0	1,040	0.1456	52.1	2,084	0.2918	77.4	2,976	0.4166
	Hotel	-	-	17,000	11.3	-	0.1921	22.5	-	0.3825	32.2	-	0.5474
	SUB TOTAL	-	-	-	60.5	1,342	0.3795	120.9	2,687	0.7576	175.8	3,837	1.0832
#18 to #22	Residential	13	140	1,800	87.6	1,139	0.1577	175.1	2,276	0.3152	250.2	3,253	0.4504
	Hotel	-	-	17,000	34.7	-	0.5899	69.4	-	1.178	99.2	-	1.6864
	Commercial	-	-	6,000	3.9	-	0.0234	7.8	-	0.0468	11.2	-	0.0672
	SUB TOTAL	-	-	-	126.2	1,139	0.7710	252.3	2,276	1.5400	360.6	3,253	2.2040
#23 to #27	Residential	13	140	1,800	33.0	429	0.0594	66.0	858	0.118	94.3	1,226	0.1697
	Apartment	40	140	5,600	2.3	92	0.0129	4.6	184	0.0258	6.5	260	0.0364
	Hotel	-	-	17,000	13.0	-	0.2210	25.9	-	0.4403	37.0	-	0.6290
	Commercial	-	-	6,000	3.6	-	0.0216	7.3	-	0.0438	10.4	-	0.0624
	SUB TOTAL	-	-	-	51.9	521	0.3149	103.8	1,042	0.6279	148.2	1,486	0.8975

TABLE NO. I-12

ADOPTED DESIGN CRITERIA
FOR
NAPILI-KAANAPALI-LAHAINA

Area	Land Use	Per Acre	GPCD	GPAD	1980 % of Max Development			1990 % of Max Development			Max Development (2,000)		
					Acres	Population	Flow	Acres	Population	Flow	Acres	Population	Flow
#28 to #33	Residential	13	140	1,800	17.6	229	0.0317	35.3	458	0.0634	50.4	655	0.0907
	Apartment	40	140	5,600	48.2	1,928	0.2699	96.5	3,856	0.5398	137.8	5,512	0.7717
	Commercial	-	-	6,000	4.2	-	0.0252	8.4	-	0.0504	12.0	-	0.0720
	SUB TOTAL	-	-	-	70.0	2,157	0.3268	140.2	4,314	0.6536	200.2	6,167	0.9344
#34 to #50	Residential	13	140	1,800	207.0	2,691	0.3726	414.0	5,382	0.7452	591.4	7,688	1.0645
	Apartment	40	140	5,600	35.7	1,428	0.1999	71.3	2,856	0.3998	101.9	4,076	0.5706
	Hotel	-	-	17,000	114.7	-	1.9499	229.5	-	3.9000	327.8	-	5.5726
	Commercial	-	-	6,000	9.0	-	0.0540	18.0	-	0.1080	25.7	-	0.1542
	SUB TOTAL	-	-	-	366.4	4,119	2.5764	732.8	8,238	5.1530	1,046.8	11,764	7.3619
#51 to #54 and 59, 61, 62	Residential	13	140	1,800	55.0	715	0.0990	109.9	1,429	0.1978	157.0	2,041	0.2826
	Apartment	40	140	5,600	35.0	1,400	0.1960	70.0	2,800	0.3920	100.0	4,000	0.5600
	Hotel	-	-	17,000	4.4	-	0.0748	8.8	-	0.1496	12.6	-	0.2142
	Public	-	-	1,700	44.2	-	0.0751	88.5	-	0.1505	126.4	-	0.2149
	SUB TOTAL	-	-	-	138.6	2,115	0.4449	277.2	4,229	0.8899	396.0	6,041	1.2717
#55 and 1/2 #63	Residential	13	140	1,800	71.8	933	0.1292	143.5	1,866	0.2583	205.0	2,665	0.3690
	Public	-	-	1,700	45.5	-	0.0774	91.0	-	0.1547	130.0	-	0.2210
	SUB TOTAL	-	-	-	117.3	933	0.2066	234.5	1,866	0.4130	335.0	2,665	0.5900

TABLE NO. I-13

ADOPTED DESIGN CRITERIA
FOR
NAPILI-KAANAPALI-LAHAINA

Area	Land Use	Per Acre	GPCD	GPAD	1980 % of Max Development			1990 % of Max Development			Max Development (2,000)		
					Acres	Population	Flow	Acres	Population	Flow	Acres	Population	Flow
#56, 1/4	Residential	13	140	1,800	64.4	837	0.1159	128.8	1,674	0.2318	184.0	2,392	0.3312
#63, #64	Apartment	40	140	5,600	13.0	520	0.0728	25.9	1,036	0.1450	37.0	1,480	0.2072
and #65	Commercial	--	--	6,000	2.6	--	0.0156	5.1	--	0.0306	7.3	--	0.0438
	SUB TOTAL	--	--	--	80.0	1,357	0.2043	159.8	2,710	0.4074	228.3	3,872	0.5822
#57, #58,	Residential	13	140	1,800	104.3	1,356	0.1877	208.6	2,712	0.3755	298.0	3,874	0.5364
1/4 #63,	Industrial	--	--	--	28.4	--	0.1704	56.8	--	0.3498	81.2	--	0.4872
	SUB TOTAL	--	--	--	132.7	1,356	0.3581	265.4	2,712	0.7163	379.2	3,874	1.0236
#66 to #71	Residential	13	140	1,800	22.9	298	0.0412	45.9	597	0.0826	65.5	852	0.1179
	Apartment	40	140	5,600	5.5	220	0.0308	10.9	436	0.0610	15.6	624	0.0874
	Hotel	--	--	17,000	0.6	--	0.0102	1.3	--	0.0221	1.8	--	0.0306
	Commercial	--	--	6,000	7.7	--	0.0462	15.4	--	0.0924	22.0	--	0.1320
	Public	--	--	1,700	32.1	--	0.0546	64.3	--	0.1093	91.8	--	0.1561
	SUB TOTAL	--	--	--	68.8	518	0.1830	137.8	1,033	0.3674	196.7	1,476	0.5240
	TOTAL	--	--	--	1,291.7	16,638	5.9797	2,583.4	33,268	11.9539	3,693.4	47,520	17.0833

TABLE NO. I-14
ADOPTED DESIGN CRITERIA
FOR
NAPILI-KAANAPALI-LAHAINA

AREA	POPULATION		ESTIMATED WATER DEMAND								STORAGE				
			Mean Daily		Max Day		Peak Hourly		Fire Flow		Duration	Fire Flow		Peak Flow	
	1980	1990	1980	1990	1980	1990	1980	1990	1980	1990	Hours	Req'd	Exist.	Req'd	New
# 1 to #13	1,405	2,810	0.374	0.749	0.561	1.124	0.935	1.873	1,200	1,700	6.8	0.69	-	0.27	0.45
#14 to #19	1,267	2,537	0.265	0.530	0.398	0.796	0.663	1.326	1,053	1,634	6.4	0.63	0.07	0.62	0.60
#20 to #27	1,409	2,818	1.028	2.056	1.542	3.084	2.570	5.140	1,200	1,700	6.8	0.69	0.07	0.32	0.40
#28 to #33	2,157	4,314	0.327	0.654	0.491	0.982	0.818	1.636	2,030	2,779	10	1.67	-	1.34	1.35
#34 to #50	4,119	8,238	2.576	5.153	3.864	7.728	6.440	12.880	1,541	2,082	8.3	1.04	1.5	0.75	-
#51 to #62	3,375	6,749	0.867	1.734	1.301	2.601	2.168	4.335	1,844	2,594	10	1.56	-	0.62	-
#63 to #71	2,899	5,798	0.529	1.058	0.794	1.587	1.323	2.645	1,750	2.450	9.8	1.44	0.27	0.38	0.65
TOTAL	16,631	33,264	5.966	11.934	8.951	17.902	14.917	29.835	10,618	14,939					

NOTE: MEAN DAILY, MAX. DAY, AND PEAK HOURLY FLOWS IN MED; FIRE FLOW IN GPM

f. Source

Ground water is available in this area, but with little cap rock, the fresh water lens is thin near the shoreline. Another source is the extensive dike system found in the upper regions of the Lahaina District. The State has investigated the possibility of high-level dike water in the Kanaha Stream area above Lahainaluna High School but has had poor results in the two test wells.

At the present time, the State is planning to explore the possibility of tapping the basal water at Kanaha Stream above Lahainaluna High School. They are also investigating the feasibility of tapping the basal ground water in the Alaeloa Area.

Presently, the Kaanapali Resort is developing its own water distribution system. This system is independent of the County's system. However, it may be incorporated in the future providing the system complies with all County requirements.

The water distribution systems proposed in this study are based on the utilization of basal water sources. The Department of Land and Natural Resources, State of Hawaii, is investigating this area. If it is not feasible to utilize the basal water in the area, a water source from the Honokahau area will need to be developed.

If the new sources of water for the Lahaina Town and Kaanapali system prove inadequate, other sources, possibly north of Napili, may have to be found and transmitted into the area. Should this be required, the existing sources could serve the upper areas of Lahaina Town and Kaanapali, while the new source could serve the lower or coastal areas.

g. Proposed Development

With the existing water delivery capabilities, the Lahaina Town System will be capable of handling the maximum daily demands for the area until 1980. A review of those figures as presented in Table I-12 indicates that the Alaeloa-Kahana and Honokohau systems will not be able to meet the demands for the average flow of 1980. A new source of water will have to be provided prior to 1974 to replace the Honokohau Tunnel source.

The proposed plan for the installation of the County's water system are shown schematically on Plates 18 and 19, and the development plans are illustrated on Plate 20.

The development of this system is proposed to be completed in various stages to meet the projected 1990 demands. The program would essentially be two systems with the sources being located in the Lahaina Town area and the Napili or Alaeloa area. The development of the Kaanapali system is not included in this plan.

The development of the water system for Napili to Honokowai is proposed to be carried out in the following stages:

(1) Stage I

The first phase of the development in this area includes:

(a) The drilling of a 1.0 MG well at Napili;

(b) The installation of approximately 5,000 to 6,000 linear feet of 12" pipeline leading from the well to the transmission main;

(c) The development of a 1.0 MG storage tank above Alaeloa; and

(d) The drilling of a second 1.0 MG well at Napili.

(2) Stage II

Stage II includes:

(a) The installation of 3,000 linear feet of 12" pipeline from the storage tank above Alaeloa to Honoapiilani Highway;

(b) The installation of 14,000 linear feet of 16" pipeline along Honoapiilani Highway from Kanaha to Honokowai;

(c) A 1.0 MG storage tank is to be installed above Honokowai, and 3,000 linear feet of 12" pipeline from the tank to Honokowai

(d) The installation of a second 1.0 MG storage tank at the proposed site above Alaeloa.

(3) Stage III

This stage includes:

(a) The development of the area from Napili Bay to Honokahau Bay by Maui Land & Pineapple Company;

(b) Development of a 3 MGD well, a 3 MG storage tank and the installation of approximately 11,000 linear feet of 16" pipeline and 9,000 linear feet of 12" pipeline.

The proposed development for the Lahaina area is as follows:

(1) Stage I

(a) Installation of a 0.5 MG storage tank at Lahaina with approximately 1,500 linear feet of 16" pipeline to the existing 10" transmission main;

(b) Development of the Kanaha well, the completion of approximately 2,500 linear feet of 12" pipeline from the well to the pipeline installed in item (a) above, and the installation of a 0.5 MG reservoir at Lahaina;

(c) Development of the second Kanaha well and the installation of approximately 2,000 linear feet of 8" pipeline to the 12" pipeline installed in item (b); and

(d) The installation of approximately 5,100 linear feet of 16" pipeline from the 0.5 MG reservoir established in item (a) above to Front Street.

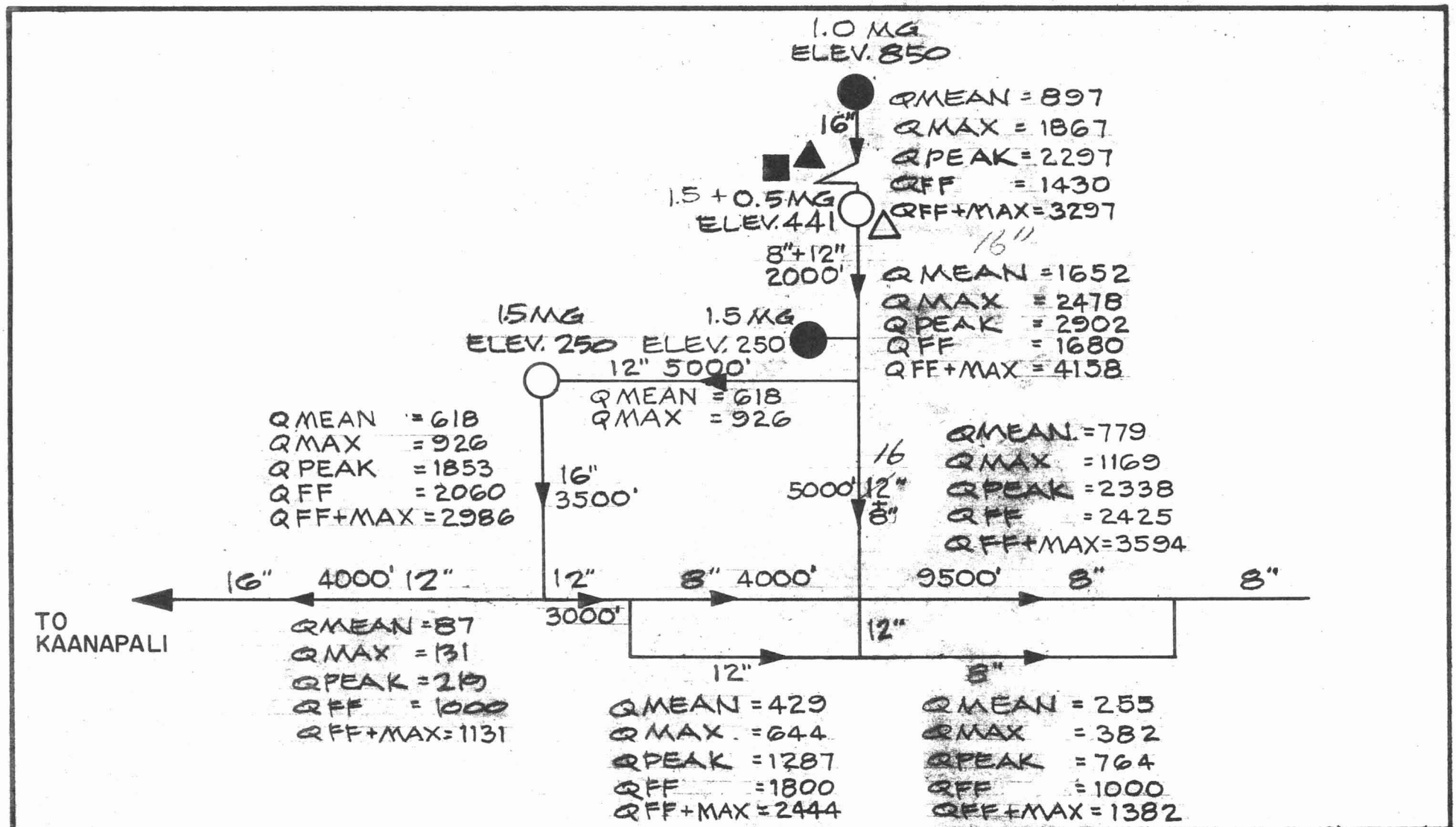
(2) Stage II

(a) The installation of approximately 13,000 linear feet of 12" pipeline and 3,200 linear feet of 8" pipeline within Lahaina;

(b) Provide a 1.0 MG storage tank elevation 250 feet and the installation of approximately 6,000 linear feet of 12" pipeline from the 16" transmission main installed as Item (1) (d) above to the existing 1.5 MG storage tank at elevation 250 feet;

(c) The installation of a third well to service the Lahaina area (not indicated on plan); and

(d) The development of a 1.0 MG storage tank and approximately 6,000 linear feet of 16" pipeline from this well site/reservoir to the second Kanaha well.



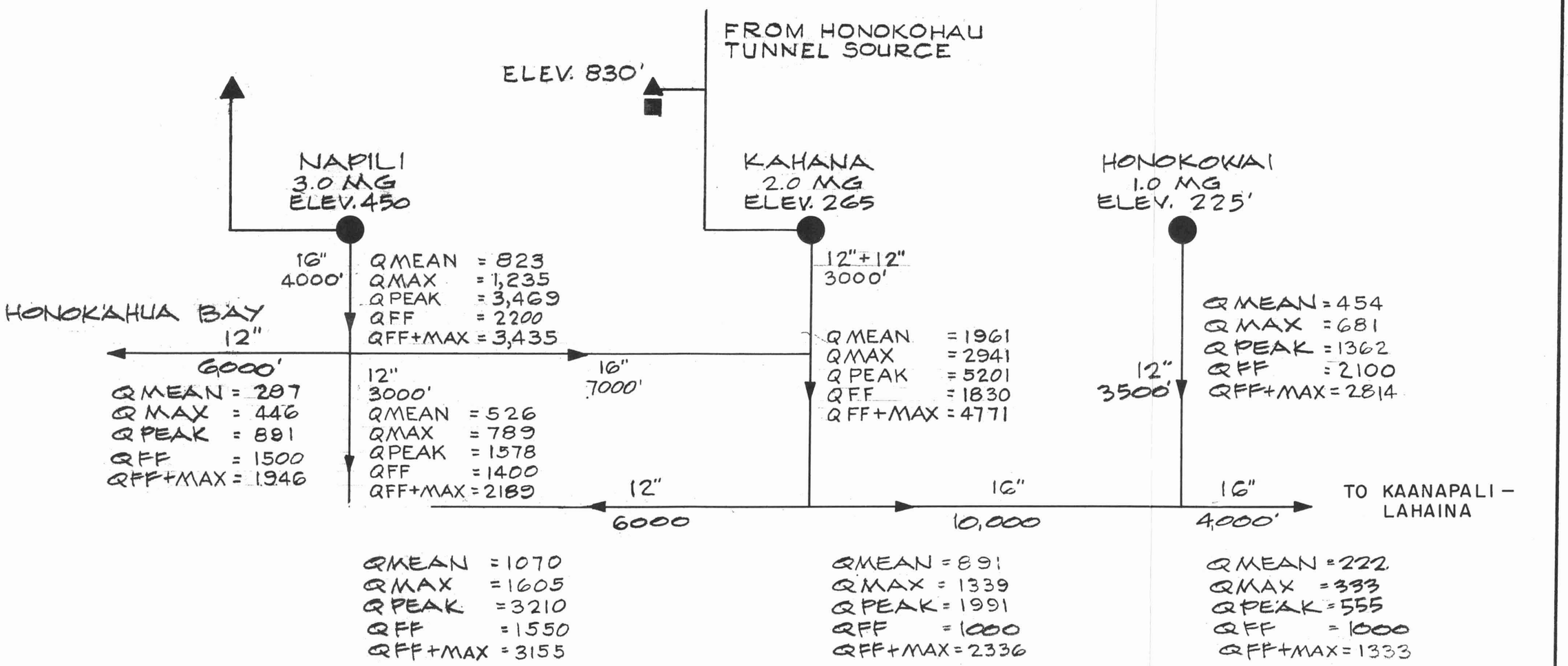
NOTE: FLOWS IN GPM

COUNTY OF MAUI

WATER MASTER PLAN
SCHEMATIC DIAGRAM FOR
WATER SYSTEM PROPOSAL
FOR
LAHAINA

R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS

PLATE 18

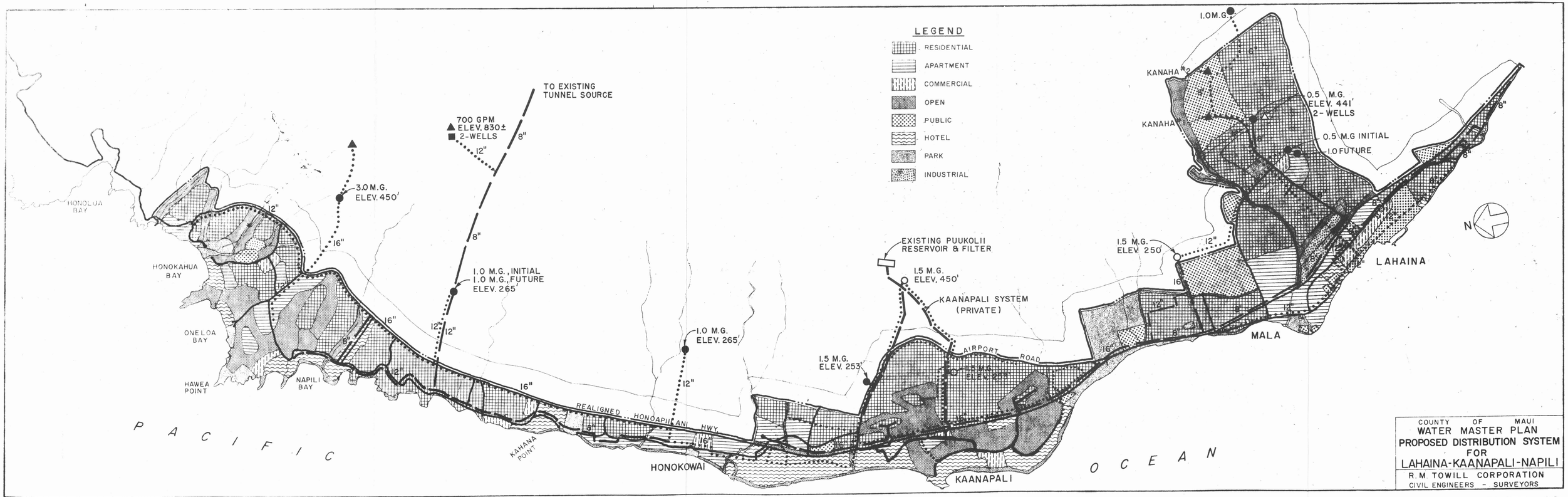


NOTE: FLOWS IN GPM

COUNTY OF MAUI
WATER MASTER PLAN
SCHEMATIC DIAGRAM FOR WATER SYSTEM PROPOSAL FOR
NAPILI TO HONOKOWAI

R. M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 19



COUNTY OF MAUI
WATER MASTER PLAN
PROPOSED DISTRIBUTION SYSTEM
FOR
LAHAINA-KAANAPALI-NAPILI
R. M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

PLATE 20

3. Maalaea-Kihei-Makena

a. Limits of Study

The Maalaea-Kihei-Makena study area, located on the south central shoreline of the island, encompasses 1,200 acres of land between the east side of McGregor Point and the north side of LaPerouse. The limits of study for this area are illustrated on Plate 21.

b. Economic Conditions

Although to some extent a small amount of diversified agriculture and cattle grazing provides some contribution to the area's economy, no major industry is presently located within the study area. The existing tourist facilities and those planned for future development will become the major generators of employment in the area. The region is also expected to grow as a residential support community, particularly for the Wailuku-Kahului Urban Center.

c. Land Use and Water Demand Area

The County's General Plan for development study is illustrated on Land Use Map, Plate 21. Table I-15 summarizes the number of acres allotted for each type of zoning classification. Water demand areas for this location are illustrated on Plate 22 and are listed in tabular form on Table I-16.

TABLE NO. I-15

SUMMARY OF ZONING ACREAGE

MAALAEA-KIHEI-MAKENA

Land Use	Area in Acres
Residential	2,345.0
Industry	37.1
Commercial	237.0
Apartment	599.9
Park	28.2
Hotel	469.4
Public	161.5
Rural	538.0

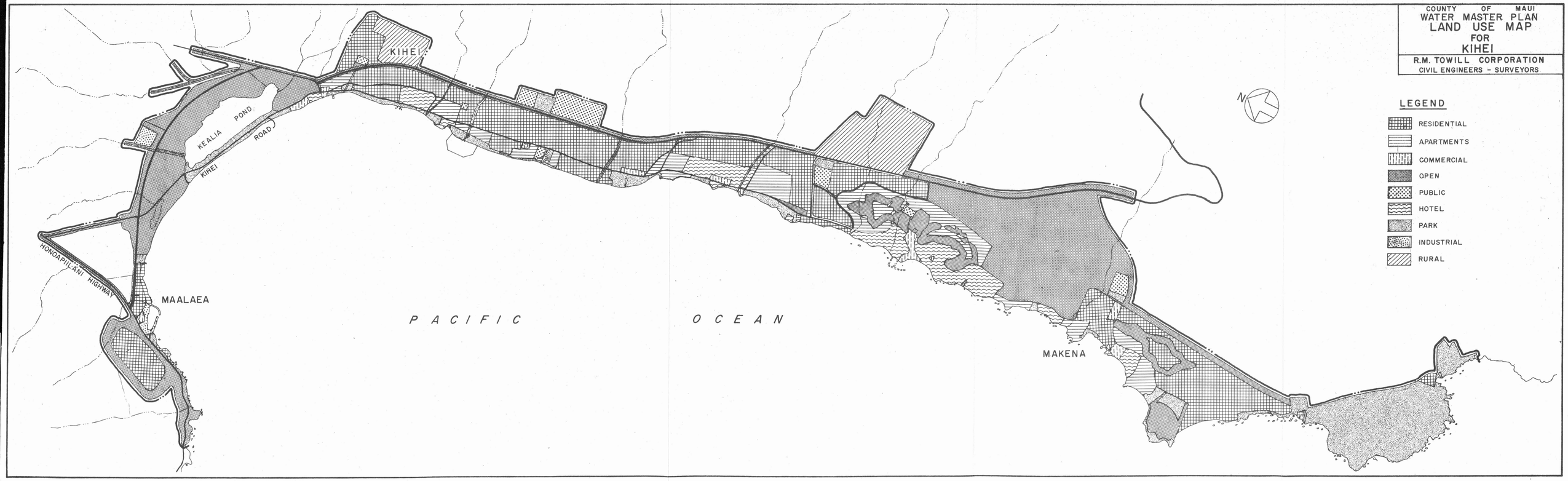

COUNTY OF MAUI
WATER MASTER PLAN
LAND USE MAP
FOR
KIHEI
R.M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS
LEGEND
RESIDENTIAL
APARTMENTS
COMMERCIAL
OPEN
PUBLIC
HOTEL
PARK
INDUSTRIAL
RURAL
N
KIHEI
KEALIA POND
KIHEI ROAD
HONOAPIILANI HIGHWAY
MAALAEA
PACIFIC OCEAN
MAKENA

PLATE 21

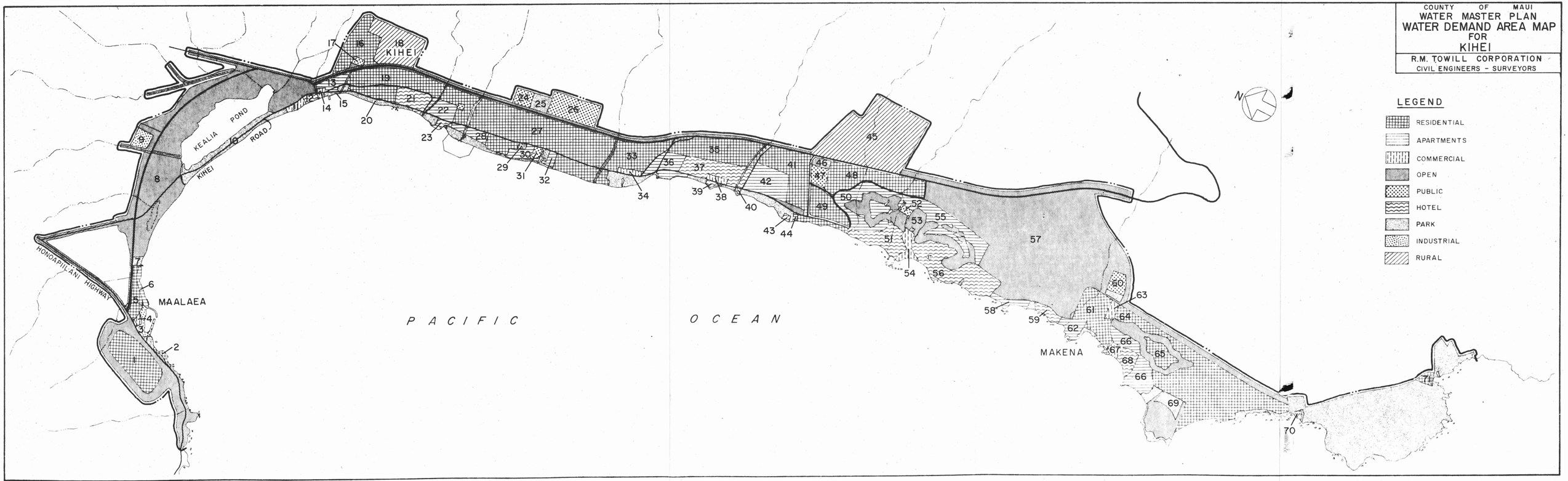

COUNTY OF MAUI
WATER MASTER PLAN
WATER DEMAND AREA MAP
FOR
KIHEI
R.M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS
LEGEND
RESIDENTIAL
APARTMENTS
COMMERCIAL
OPEN
PUBLIC
HOTEL
PARK
INDUSTRIAL
RURAL
N
KIHEI
KEALIA POND
KIHEI ROAD
HONOAPIILANI HIGHWAY
MAALAEA
MAKENA
PACIFIC OCEAN

PLATE 22

TABLE NO. I-16

AREA DESIGNATION/LAND USE/ACREAGE

MAALAEA-KIHEI-MAKENA

Area No.	Land Use	Acreage
1	Residential	150.0
2	Residential	6.0
3	Industrial	11.9
4	Commercial	5.0
5	Residential	34.4
6	Apartment	14.9
7	Park	5.2
8	Open	
9	Industrial	25.2
10	Park	
11	Commercial	13.3
12	Hotel	8.2
13	Apartment	36.7
14	Commercial	3.0
15	Park	
16	Residential	112.0
17	Public	3.0
18	Rural	138.0
19	Residential	218.0
20	Park	
21	Hotel	50.2
22	Apartment	41.2
23	Hotel	6.8
24	Public	23.0
25	Park	23.0
26	Public	92.0
27	Residential	464.0
28	Apartment	21.8
29	Commercial	2.8
30	Apartment	22.8
31	Public	12.0
32	Apartment	6.8
33	Residential	118.0
34	Commerical	9.7
35	Residential	171.5
36	Apartment	75.4
37	Hotel	93.5
38	Commercial	4.6
39	Hotel	4.6
40	Commercial	2.0
41	Residential	142.0
42	Apartment	83.4
43	Hotel	2.5
44	Hotel	2.3
45	Rural	400.0
46	Park	
47	Public	2.5
48	Residential	170.0
49	Residential	110.0
50	Apartment	77.0
51	Hotel	73.5
52	Public	4.0
53	Open	
54	Commercial	52.8
55	Apartment	73.4
56	Hotel	178.0
57	Open	
58	Apartment	27.0
59	Hotel	20.0
60	Public	25.0
61	Residential	124.0
62	Apartment	37.5
63	Commercial	13.2
64	Residential	468.0
65	Residential	42.8
66	Apartment	82.0
67	Commercial	11.8
68	Hotel	29.8
69	Park	
70	Residential	2.7
71	Residential	11.6

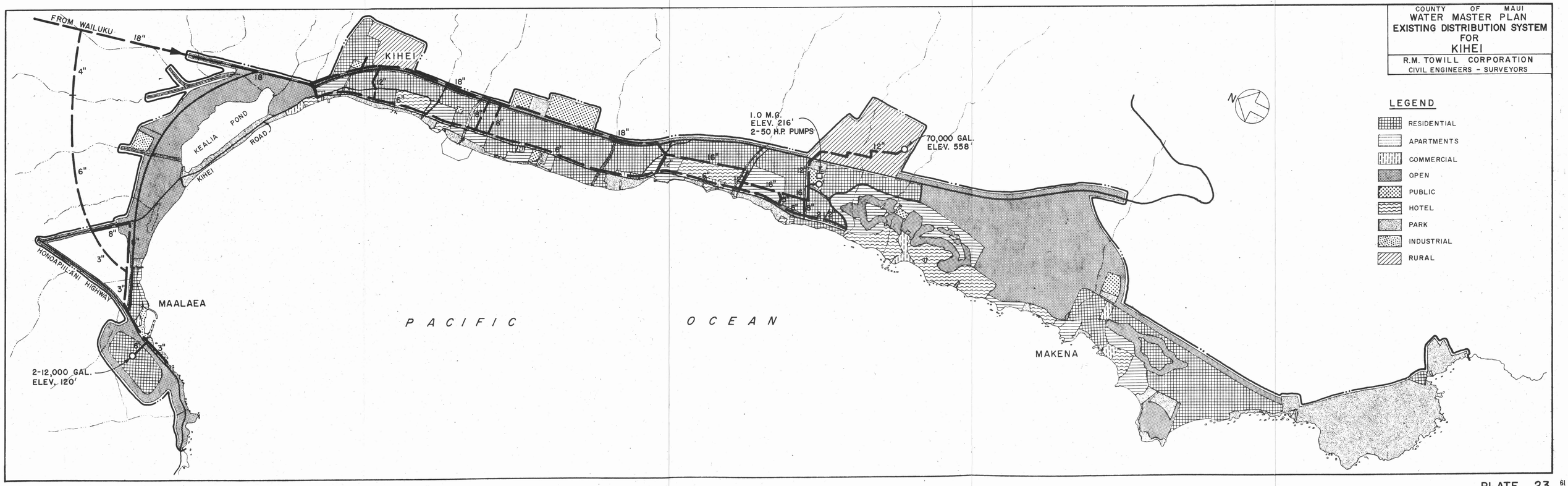
d. Existing Facilities

The water facility for Maalaea-Kihei-Makena is a sub-system of the Wailuku-Kahului system. It has as its source of water the Mokohau well and the Iao Tunnel. The water is transported across the central isthmus of Maui to the Kihei-Maalaea area by an 18" transmission pipeline as illustrated on Plate 23. The pipeline parallels the coast of Kihei and terminates with a 16" pipeline at a 1.0 million gallon reservoir at the Wailuku-Makawao boundary. The Department of Land and Natural Resources study entitled "Water for Kihei-Makena" lists the delivery capacity of the system as 2.5 million gallons per day. The report also lists the present consumption of the Maalaea-Kihei-Makena area as approximately 0.32 million gallons per day.

e. Future Consumption

The future consumption of the Maalaea-Kihei-Makena area is projected at 6.2 million gallons per day for 1980 and 12.3 million gallons per day for 1990 (Table I-17). The maximum daily demand is projected at 9.2 MGD for 1980 and 18.5 MGD for 1990 (Table I-18).

The water demand listed in Tables I-17 and I-18 is higher than the figures at which the Department of Land and Natural Resources arrived in the report, "Water for Kihei-Makena". In the report, the projected demand for 1990 was listed as 12.3 MGD for the mean daily flow.



COUNTY OF MAUI
WATER MASTER PLAN
EXISTING DISTRIBUTION SYSTEM
FOR
KIHEI

R.M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

PLATE 23

TABLE NO. I-17
ADOPTED DESIGN CRITERIA
FOR
MAALAEA-KIHEI-MAKENA

Area	Land Use	Per Acre	GPCD	GPAD	1980 35% of Max Development Acres	1980 35% of Max Development Population	1980 35% of Max Development Flow	1990 70% of Max Development Acres	1990 70% of Max Development Population	1990 70% of Max Development Flow	Max Development (2,000) Acres	Max Development (2,000) Population	Max Development (2,000) Flow
# 1 to #11													
MAALAEA	Residential	13	140	1,800	66.6	866	0.1199	133.3	1,732	0.2399	190.4	2,475	0.3427
	Apartment	40	140	5,600	5.3	209	0.0297	10.6	418	0.0594	14.9	596	0.0834
	Commercial	-	-	6,000	1.8	-	0.0108	3.5	-	0.0210	5.0	-	0.0300
	Industrial	-	-	6,000	12.9	-	0.0774	25.8	-	0.1548	36.9	-	0.2214
	SUBTOTAL	-	-	-	86.6	1,075	0.2378	173.2	2,150	0.4751	247.2	3,071	0.6775
#12 to #38													
N. KIHEI	Residential	13	140	1,800	379.2	4,930	0.6826	758.5	9,861	1.365	1,083.5	14,086	1.9503
	Apartment	40	140	5,600	71.6	2,864	0.4010	143.3	5,732	0.802	204.7	8,188	1.1463
	Hotel	-	-	17,000	57.2	-	0.9724	114.3	-	1.943	163.3	-	2.7761
	Commercial	-	-	6,000	7.0	-	0.0420	14.1	-	0.085	20.1	-	0.1206
	Public	-	-	1,700	45.5	-	0.0774	96.6	-	0.174	130.0	-	0.2210
	Rural	5	-	1,800	48.3	242	0.0869	91.0	455	0.155	138.0	675	0.2484
	SUBTOTAL	-	-	-	608.8	8,036	2.2623	1,217.8	16,048	4.524	1,262.3	22,949	6.4627
#39 to #58													
S. KIHEI	Residential	13	140	1,800	147.7	1,920	0.2659	295.4	3,840	0.5317	422.0	5,486	0.7596
	Apartment	40	140	5,600	91.3	3,652	0.5113	182.6	7,304	1.0226	260.8	10,432	1.4605
	Hotel	-	-	17,000	89.7	-	1.5249	179.4	-	3.0498	256.3	-	4.3571
	Commercial	-	-	6,000	19.2	-	0.1152	38.4	-	0.2304	54.8	-	0.3288
	Rural	5	-	1,800	140.0	-	0.2520	280.0	-	0.5040	400.0	-	0.7200
	Public	-	-	1,700	2.3	-	0.0039	4.6	-	0.0078	6.5	-	0.0111
	SUBTOTAL	-	-	-	490.2	5,572	2.6732	980.4	11,144	5.3463	1,400.4	15,918	7.6371
#59 to #71													
MAKENA	Residential	13	140	1,800	144.9	1,884	0.2608	289.8	3,767	0.5216	414.0	5,382	0.7452
	Apartment	40	140	5,600	40.6	1,624	0.2274	81.2	3,248	0.4547	116.0	4,640	0.6496
	Hotel	-	-	17,000	17.5	-	0.2975	35.0	-	0.5950	50.0	-	0.8500
	Commercial	-	-	6,000	8.8	-	0.0528	17.5	-	0.1050	25.0	-	0.1500
	Public	-	-	1,700	8.8	-	0.1496	17.5	-	0.2975	25.0	-	0.4250
	SUBTOTAL	-	-	-	220.6	3,508	0.9881	441.0	7,015	1.9738	630.0	10,022	2.8198
TOTAL		-	-	-	1,406.2	18,191	6.1614	2,812.4	36,357	12.3192	3,539.9	51,960	17.5971

TABLE NO. I-18

ADOPTED DESIGN CRITERIA
FOR
MAALAEA-KIHEI-MAKENA

AREA	POPULATION		ESTIMATED WATER DEMAND								STORAGE			
			Mean Daily		Max Day		Peak Hourly		Fire Flow			Fire Flow		Peak Flow	
	1980	1990	1980	1990	1980	1990	1980	1990	1980	1990	Duration Hours	Req'd	Exist.	Req'd	New
# 1 to # 7 MAALAEA	1,075	2,150	0.238	0.475	0.357	0.713	0.714	1.425	1,035	1,538	6.2	0.572	0.024	0.3560	1.0
# 8 to #38 NORTH KIHEI	8,036	16,048	2.262	4.524	3.393	6.786	6.786	13.572	2,750	3,875	10	2.325	-	3.391	7.0
#39 to #58 SOUTH KIHEI	5,572	11,144	2.673	5.346	4.010	8.019	8.019	16.038	2,393	3,190	10	1.914	1.4	4.007	8.0
#59 to #71 MAKENA	3,508	7,015	0.988	1.974	1.482	2.961	2.964	5.922	1,875	2,650	10	1.590	-	1.4796	3.0
TOTAL	18,191	36,357	6.161	12.319	9.242	18.479	18.483	36.957							

The difference in estimated demands is attributed to the basic method of establishing the water requirement. In this report, the water demand is established on a per acre basis and the actual amount required is based on a percentage of ultimate land use for the year considered (1990).

f. Proposed Development

The development for the Kihei area is proposed in 4 stages:

(1) Stage I - This phase includes:

(a) Development of a 3.0 MG storage tank at north Kihei;

(b) Installation of 6,000 feet of 16" pipeline from the tank to the existing pipeline;

(c) Development of a 2.0 MG storage tank at Waialia;

(d) Installation of 23,000 feet of 18" pipeline from Kamaole to Makena.

(2) Stage II - The second phase of the plan includes:

(a) Drilling of a 3.0 MGD well at upper Kihei;

(b) The installation of 16,000 feet of 12" pipeline from the well to Kihei;

(c) Drilling of a 9.0 MGD well source at Waikapu;

(d) The installation of 2,000 feet of 24" pipeline from Waikapu wells to the existing 18" pipeline. (Plate 28)

(3) Stage III - Stage III includes:

(a) The increasing of Waikapu source by 3.0 MGD;

(b) The installation of 43,500 feet of 24" pipeline from Waikapu to Kihei;

(c) The development of a 1.0 MG storage tank at south Kihei including 4,000 feet of pipeline from the tank to the existing 18" pipeline;

(d) Development of a second 2.0 MG storage tank at

Waialea and approximately 3,000 feet of 16" pipeline from the tank to 18" pipeline installed in Stage I, (d).

(4) Stage IV

(a) Development of a third 2.0 MG storage tank at Waialea; and approximately 2,000 feet of 16" pipeline from the storage tank to the 18" line installed in Stage I, (d).

(b) The installation of 26,000 feet of 24" pipeline from Kihei to Kamaole.

(c) Development of an additional 2.0 MG storage tank at south Kihei.

(5) Stage V

The installation of a 0.5 MG storage tank at approximately elevation 700 feet above Waialea, the completion of a 0.3 MG storage tank at elevation 558 in this same area and the installation of approximately 3,000 feet of 12" pipeline between these two storage facilities.

The development for the Maalaea area is proposed as follows:

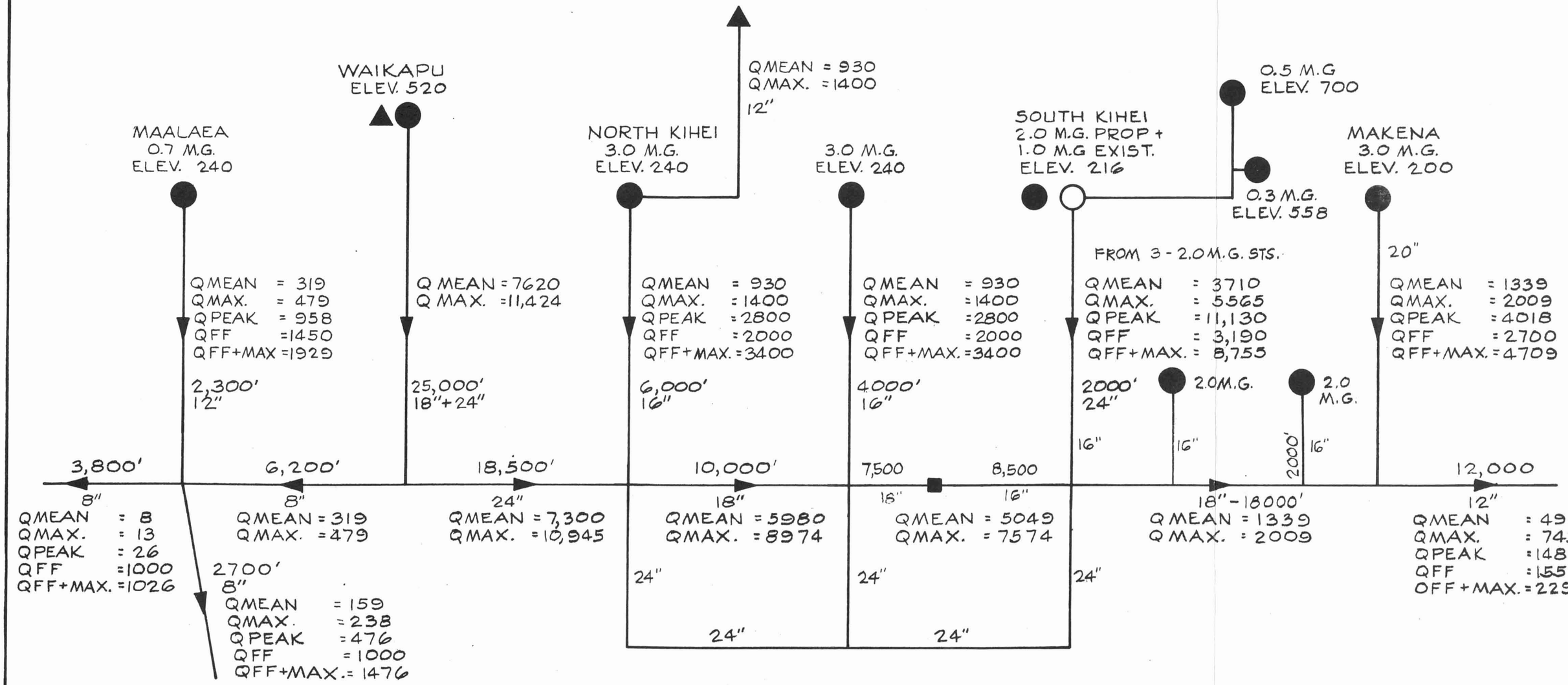
Installation of approximately 6,500 feet of 8" pipeline and the installation of approximately 2,300 linear feet of 12" pipeline. Provide a 0.7 MG storage reservoir as shown on Plate 25.

The development for the Makena area is proposed as follows:

(a) Development of a 3.0 MG storage tank at Makena and approximately 3,000 feet of 20" pipeline from tank to 18" main;

(b) The increasing of the Waikapu wells by 5.0 MGD;

(c) The installation of approximately 13,500 linear feet of 12" pipeline from Makena to Ahihi Bay.



COUNTY OF MAUI
WATER MASTER PLAN
SCHEMATIC DIAGRAM FOR WATER SYSTEM PROPOSAL FOR
MAALAEA TO MAKENA

R. M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 24

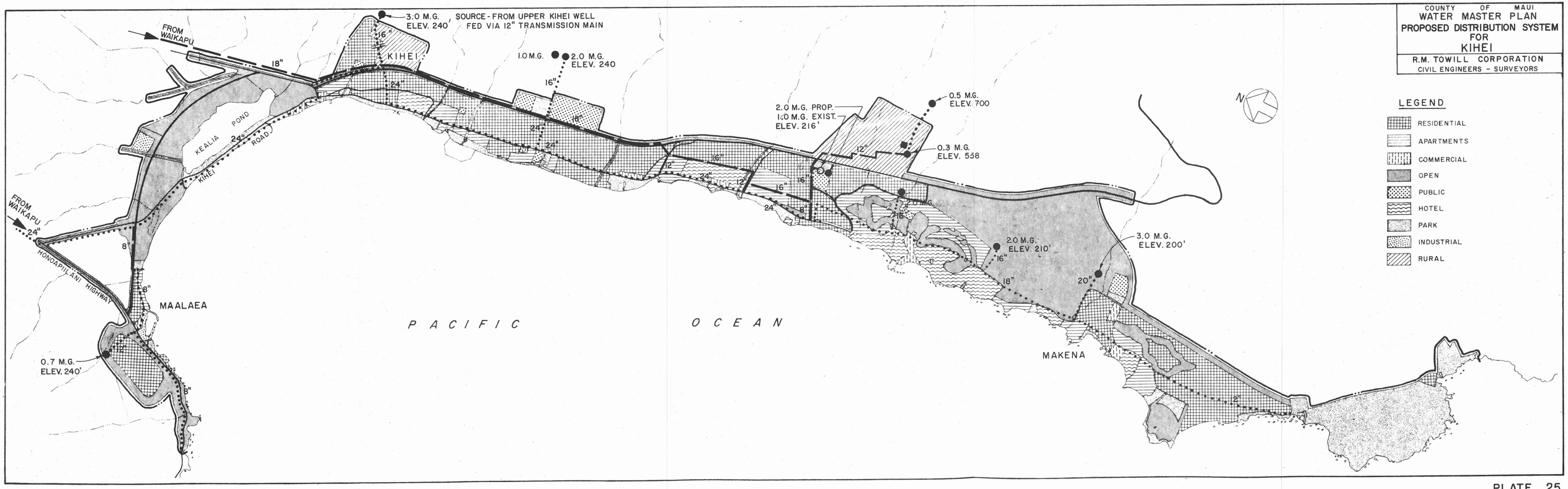

COUNTY OF MAUI
WATER MASTER PLAN
PROPOSED DISTRIBUTION SYSTEM
FOR
KIHEI
R.M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS
LEGEND
RESIDENTIAL
APARTMENTS
COMMERCIAL
OPEN
PUBLIC
HOTEL
PARK
INDUSTRIAL
RURAL
N
3.0 M.G. ELEV. 240
SOURCE - FROM UPPER KIHEI WELL FED VIA 12" TRANSMISSION MAIN
1.0 M.G.
2.0 M.G. ELEV. 240
FROM WAIKAPU
KIHEI
KEALIA POND
KIHEI ROAD
FROM WAIKAPU
HONOAPIILANI HIGHWAY
MAALAEA
0.7 M.G. ELEV. 240'
2.0 M.G. PROP.
1.0 M.G. EXIST.
ELEV. 216'
0.5 M.G. ELEV. 700
0.3 M.G. ELEV. 538
2.0 M.G. ELEV. 210'
3.0 M.G. ELEV. 200'
MAKENA
PACIFIC
OCEAN

PLATE 25

3A. Waikapu

a. Limits of Study

Located approximately in the center of the island isthmus, the Waikapu study area comprises some 92 acres of land as illustrated on Plate 26.

The Waikapu area is presented in this report as a part of the Maalaea-Makena study area because of its present significance as a future water resource area which may be developed in the near future to supply the water demand required by the Maalaea-Makena study area.

b. Economic Conditions

Waikapu primarily serves as the "country store" type of town and, as with Waihee, basically exists as a minor residential area within the vast sea of cane field agricultural lands. Additional residential developments may be forthcoming for the area and the limits of this development as stated above are outlined on the Land Use Map, Plate 26.

c. Land Use and Contributing Areas

The County of Maui has not developed a detailed General Plan for the Waikapu area, and therefore the State Land Use Maps and the urban areas designated thereon define the limits of this study area. The water demand area for Waikapu consists of that area designated for urban development as illustrated on the Land Use Map and listed in tabular form on Table I-19.

d. Existing Facilities

At present, Waikapu receives its water via a minor transmission main from the Waihee ditch as illustrated on Plate 27.

TABLE NO. I-19

ADOPTED DESIGN CRITERIA

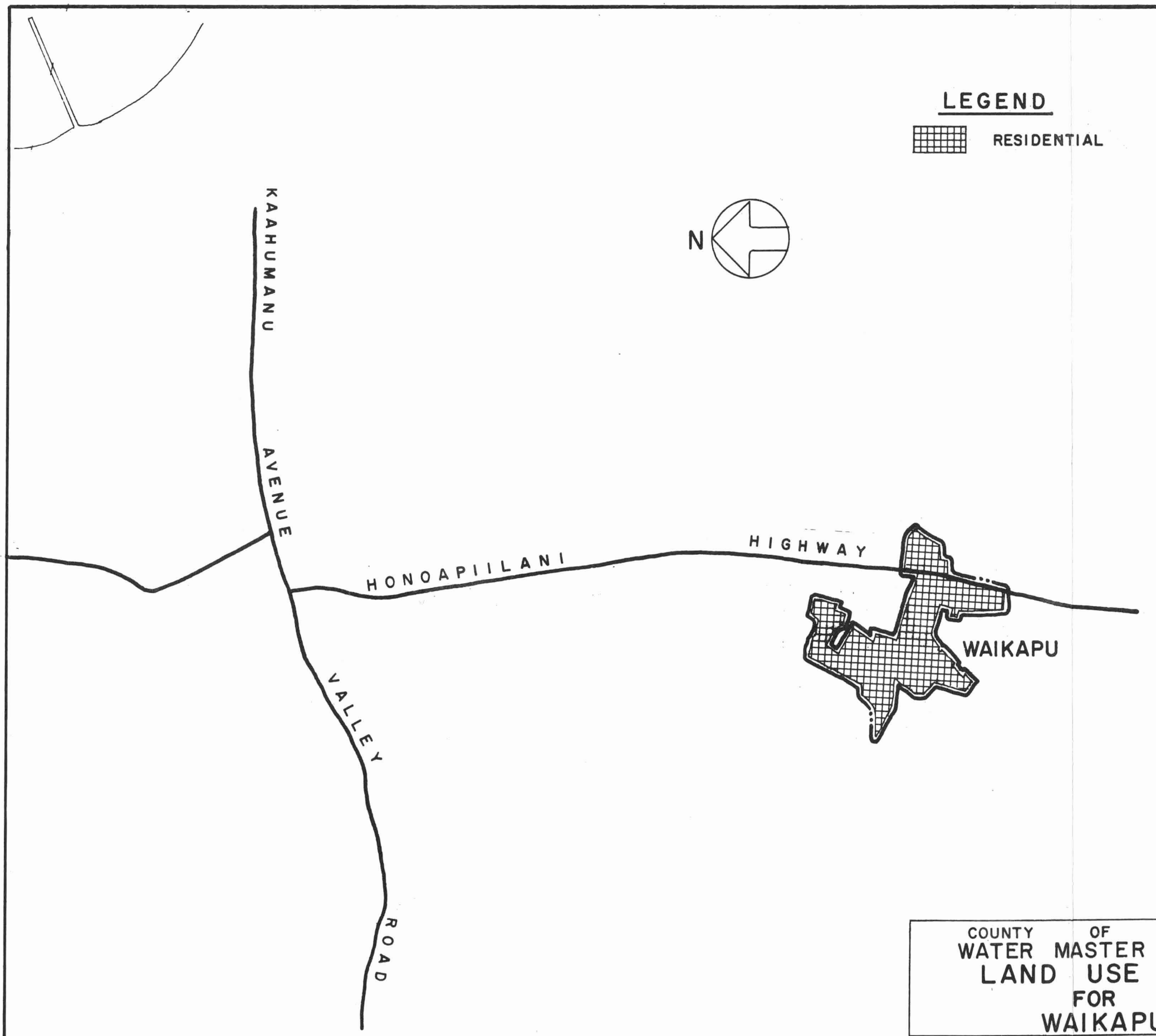
FOR

WAIKAPU

Land Use	Per Acre	GPCD	GPAD	1980 35% Max. Devel. Acres	Popu-lation	Flow	1990 70% Max. Devel. Acres	Popu-lation	Flow
Residential	13	140	1,800	32.2	418	0.0580	64.4	936	0.1159

e. Future Consumption and Water Development Plan

Future consumption figures for the Waikapu study area are presented in the above Table I-19. With the development of the 24" transmission main to Maalaea, the installation of an 8" distribution line is to be completed as illustrated on Plate 28.



COUNTY OF MAUI
WATER MASTER PLAN
LAND USE MAP
FOR
WAIKAPU

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 26

LEGEND

RESIDENTIAL

N

KAAHUMANU AVENUE

FROM WAILUKU

18"

TO KIHEI

HONOAPIILANI HIGHWAY

WAIKAPU

VALLEY ROAD

FROM WAIHEE DITCH

COUNTY OF MAUI
WATER MASTER PLAN
EXISTING DISTRIBUTION SYSTEM
FOR
WAIKAPU

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 27

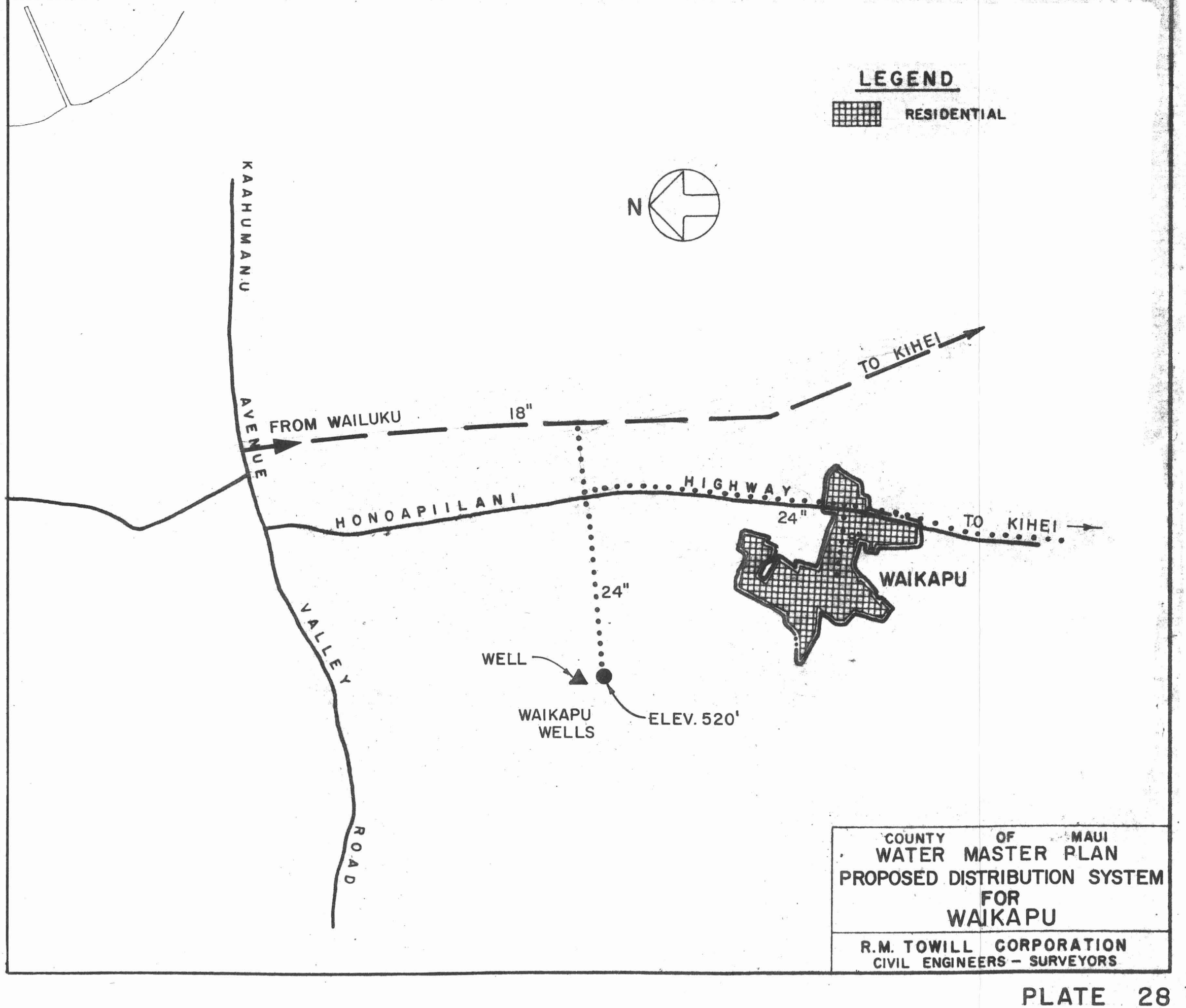

LEGEND
RESIDENTIAL
N
KAAHUMANU
AVENUE
FROM WAILUKU
18"
TO KIHEI
HONOAPIILANI
HIGHWAY
24"
TO KIHEI
WAIKAPU
24"
VALLEY
ROAD
WELL
WAIKAPU
WELLS
ELEV. 520'
COUNTY OF MAUI
WATER MASTER PLAN
PROPOSED DISTRIBUTION SYSTEM
FOR
WAIKAPU
R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 28

4. Haiku-Makawao-Pukalani

a. Limits of Study

Located on the western slopes of Haleakala, the Haiku-Makawao-Pukalani study area encompasses 3,700 acres of land. The limits of study are illustrated on Plate 29.

b. Economic Conditions

Sugar and pineapple are the two major industries for the area. Haiku is primarily an agricultural support community. Makawao and Pukalani are primarily residential areas with a good amount of diversified agriculture located between the two urbanized zones. North of Makawao and Pukalani is an area primarily utilized for cattle raising and dairy farms. Makawao and Pukalani are anticipated to grow as a residential support community for the Wailuku-Kahului commercial and industrial area. Increase in the diversified agriculture of the Makawao and Pukalani area may be expected.

c. Land Use and Water Demand Areas

The State of Hawaii has established a land use plan for the Haiku-Makawao-Pukalani area. This plan has been incorporated into this report as shown on Land Use Map, Plate 29. Table I-20 summarizes the number of acres allotted for each type of zoning classification. The water demand areas for this location are also illustrated on Plate 29.

d. Existing Facilities

The existing distribution system, as shown on Plate 30, illustrates the Haiku area water source to be the Awalau Intake at Opana Tunnel.

TABLE NO. I-20

SUMMARY OF ZONING ACREAGE

MAKAWAO-HALIIMAILE-PUKALANI

Land Use	Area in Acres
Makawao	
Residential	530.0
Haliimaile	
Residential	82.6
Pukalani	
Residential	1,100.0
Rural	340.0
	1,440

HAIKU-PAUWELA-ULUMALU-KOKOMO

Haiku	
Residential	77.0
Rural	179.3
Agricultural	180.0
Haiku School	
Residential	50.6
Pauwela	
Residential	82.6
Agricultural	205.0
Ulumalu	
Agricultural	860.0
Kokomo	
Residential	75.9

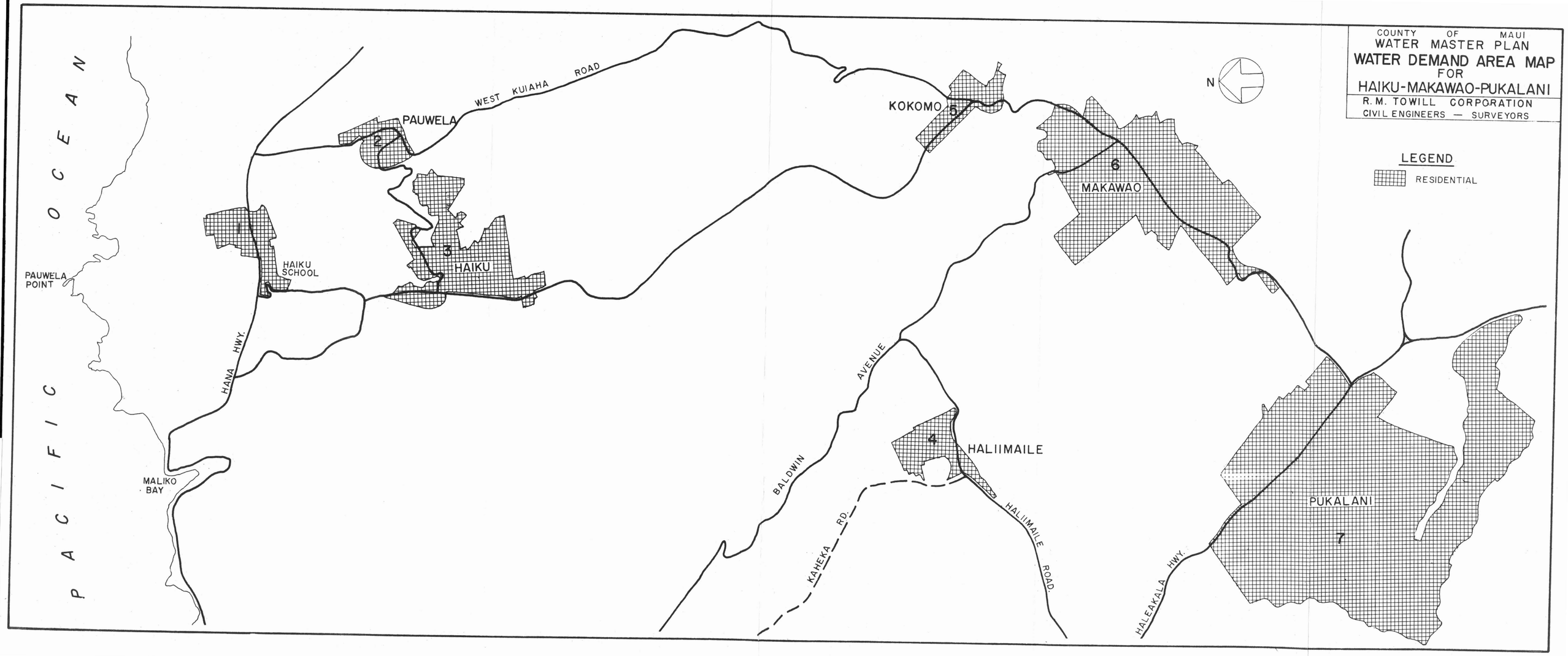

COUNTY OF MAUI
WATER MASTER PLAN
WATER DEMAND AREA MAP
FOR
HAIKU-MAKAWAO-PUKALANI
R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS
LEGEND
RESIDENTIAL
N
PACIFIC OCEAN
PAUWELA POINT
MALIKO BAY
HANA HWY.
HAIKU SCHOOL
HAIKU
PAUWELA
WEST KUIAHA ROAD
KOKOMO
MAKAWAO
HALIIMAILE
BALDWIN AVENUE
KAHEKA RD.
HALIIMAILE ROAD.
PUKALANI
HALEAKALA HWY.
1
2
3
4
5
6
7

PLATE 29

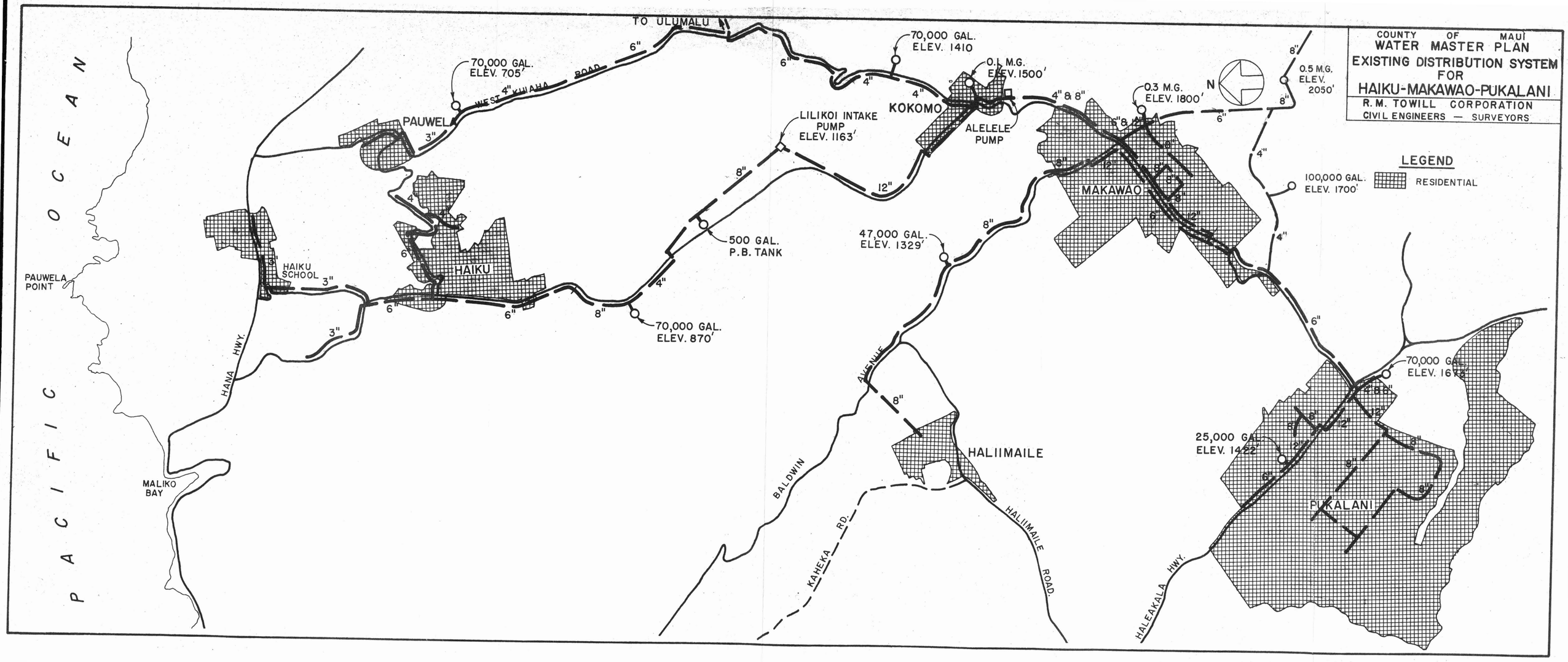

COUNTY OF MAUI
WATER MASTER PLAN
EXISTING DISTRIBUTION SYSTEM
FOR
HAIKU-MAKAWAO-PUKALANI
R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS
LEGEND
RESIDENTIAL
PACIFIC OCEAN
TO ULUMALU
70,000 GAL. ELEV. 705'
WEST 4" KIHAHA ROAD
PAUWELA
70,000 GAL. ELEV. 1410
0.1 M.G. ELEV. 1500'
KOKOMO
ALELELE PUMP
LILIKOI INTAKE PUMP ELEV. 1163'
500 GAL. P.B. TANK
70,000 GAL. ELEV. 870'
47,000 GAL. ELEV. 1329'
0.3 M.G. ELEV. 1800'
0.5 M.G. ELEV. 2050'
100,000 GAL. ELEV. 1700'
MAKAWAO
HAIKU
HAIKU SCHOOL
PAUWELA POINT
HANA HWY.
MALIKO BAY
BALDWIN AVENUE
HALIIMAILE
HALIIMAILE ROAD
KAHEKA RD.
25,000 GAL. ELEV. 1422
PUKALANI
HALEAKALA HWY.

PLATE 30 76

During periods of low stream flow, water is taken from the Wailoa Ditch at the Lilikoi Intake. Water from the Awalau Intake is transmitted through an 8" and 4" diameter pipelines to a 70,000 gallon reservoir below Kokomo at an elevation of 870 feet. The water is then transmitted to the Haiku area by a series of 8", 6", 4" and 3" pipelines. The Wailoa Ditch System diverts stream water between Alo and Halehaku Streams at an elevation of approximately 1,150 feet. Stearns and McDonald list the capacity of the Wailoa Ditch at approximately 163 million gallons per day.

An agreement between the East Maui Irrigation Company and the Hawaii Commercial & Sugar Company of 1961 ensures that 800,000 gallons per day of water from Wailoa Ditch is made available for the County system at a rate of $.04 per 1,000 gallons.

The water supply for Kokomo-Makawao-Pukalani and Haliimaile is also taken from Awalau Intake at Opana Tunnel. Water required during low flow periods (3 months/year) is again drawn from the Wailoa Ditch at the Lilikoi Intake. The Lilikoi Intake is at an elevation of 1,163 feet and, as required, water is pumped through 12" and 8" pipelines to the 0.3 MG Pookela tank at an elevation of 1,800 feet. The water then flows by gravity through a 12" pipeline to the Makawao area. From the Makawao area, water flows by gravity through an 8" pipeline to serve Haliimaile. Water from Makawao is also fed by gravity through 12" and 6" transmission lines to the 70,000 gallon Pukalani reservoir at an elevation of 1,673 feet.

Water from the Kokomo reservoir is fed by gravity to the Pauwela and Ulumalu area through a series of 4" and 16" pipelines.

e. Future Consumption

The Board of Water Supply, estimated the June 1969 - June 1970 water consumption for the Makawao District to be approximately 50,000 gallons per day for the Kokomo-Ulumalu area, 370,000 gallons per day for the Makawao area, 63,000 gallons per day for the Haliimaile area, 35,000 gallons per day for the Haiku area, and 21,000 gallons per day for the Pauwela area. The total consumption for the area is approximately 570,000 gallons per day.

The development of the flow quantities required for each of the individual sections of the study area is presented in Tables I-21 and I-22.

A summary of the estimated flows is illustrated on Table I-23. The projected mean daily flow for Haiku-Haiku School for 1980 is 446,000 gallons per day, and the projected mean daily flow for 1990 is 892,000 gallons per day. The estimated maximum daily flow is 542,000 gallons per day for 1980 and 1.09 million gallons per day for 1990, with the peak hourly flow for 1980 and 1990 estimated at 0.83 million gallons per day and 1.67 million gallons per day, respectively.

The projected mean daily flow for Ulumalu and Pauwela is estimated at 1.55 MGD for 1980 and 3.09 MGD for 1990. The maximum daily flow for 1980 and 1990 is 1.57 MGD and 3.14 MGD, respectively. The peak hourly flow is estimated at 1.65 MGD for 1980 and 3.30 MGD for 1990.

The mean daily flow, maximum daily flow and peak hourly flow estimated for Pukalani in 1980 are 1.02 MGD, 1.54 MGD and 3.07 MGD,

respectively. For 1990, the mean daily flow is estimated at 2.05 MGD with maximum daily flow at 3.07 MGD and peak hourly flow at 6.135 MGD.

It is estimated that the mean daily flow, maximum daily flow, and peak hourly flow for Makawao in 1980 will be 445,000 gallons per day, 667,000 gallons per day and 1.33 MGD, respectively. The estimated mean daily flow, maximum daily flow and peak hourly flow in 1990 will be 0.89 MGD, 1.34 MGD and 2.67 MGD, respectively.

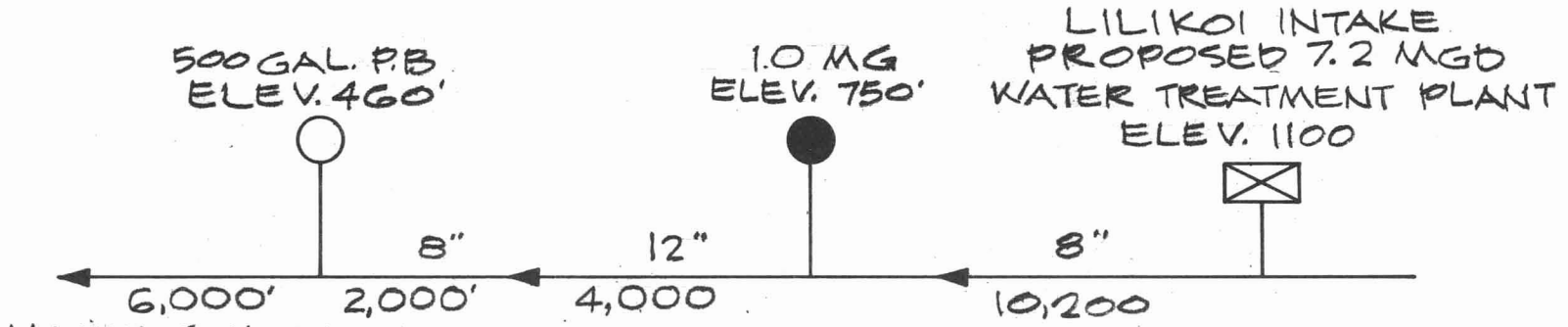
The projected water demand for the total study area in 1980 will be 3.58 MGD, mean daily flow; 5.21 MGD, maximum daily flow; and 7.39 MGD, peak hourly flow. It is also estimated that the mean daily flow, maximum daily flow, and peak hourly flow in 1990 will be 7.15 MGD, 9.13 MGD and 14.77 MGD, respectively. The estimates include the agricultural demand for the area which is estimated at 4,000 gallons per acre per day. This agricultural demand was based on the information gathered from the Soil Conservation Service and the University of Hawaii, Agricultural Extension Service.

f. Source

Investigations to date for the establishment of water resources to service this study area have included the installation of a basal water well for ground water development in the Haiku School area. While this source yielded a quality of water suitable for domestic consumption, the total quantity of water available for future area development is questionable.

ADOPTED DESIGN CRITERIA - TABLE NO. I-21
FOR
MAKAWAO - HALIIMAILE - PUKALANI

Area	Land Use	Per Acre	GPCD	GPAD	1980 35% of Max Development Acres	1980 35% of Max Development Population	1980 35% of Max Development Mean Daily Flow	1990 70% of Max Development Acres	1990 70% of Max Development Population	1990 70% of Max Development Mean Daily Flow	Max Development (2,000) Acres	Max Development (2,000) Population	Max Development (2,000) Mean Daily Flow
MAKAWAO	Residential	17	140	2,400	185.5	3,154	0.4452	371.0	6,308	0.8904	530.0	9,010	1.2720
HALIIMAILE	Residential	17	140	2,400	28.9	492	0.0694	57.8	984	0.1387	82.6	1,404	0.1982
PUKALANI	Residential	15	140	2,100	385.0	5,775	0.8085	770.0	11,550	1.6170	1,100.0	16,500	2.3100
	Rural	5	-	1,800	119.0	298	0.2142	238.0	596	0.4284	340.0	850	0.6120
	SUB TOTAL	-	-	-	504.0	6,073	1.5355	1008.0	12,146	3.0745	1,440.0	17,350	2.9220
					HAIKU-MAKAWAO-PUKALANI								
HAIKU	Residential	13	140	1,800	27.0	350	0.0486	54.0	700	0.0972	77.0	1,001	0.1386
	Rural	5	-	1,800	62.8	314	0.1130	125.6	628	0.2261	179.3	897	0.3227
	Agricultural	-	-	4,000	63.0	-	0.2520	126.0	-	0.5040	180.0	-	0.7200
	SUB TOTAL	-	-	-	152.8	664	0.4136	305.6	1,328	0.8273	436.3	1,898	1.1813
HAIKU SCHOOL	Residential	13	140	1,800	17.7	230	0.0319	34.4	460	0.0638	50.6	658	0.091
	SUB TOTAL (Haiku & Haiku School)	-	-	-	170.5	894	.4455	340.0	1,788	.8911	486.9	2,556	1.2723
	TOTAL	-	-	-	674.5	6,967	1.9810	1348.0	13,934	2.9365	1926.9	19,906	4.1943



NOTE: FLOWS IN GPM

COUNTY OF MAUI
WATER MASTER PLAN
SCHEMATIC DIAGRAM FOR
WATER SYSTEM PROPOSAL
FOR
HAIKU

R. M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 31

ADOPTED DESIGN CRITERIA - TABLE NO. I-22
FOR
HAIKU-MAKAWAO-PUKALANI

					1980 35% of Max Development			1990 70% of Max Development			Max Development (2,000)		
Area	Land Use	Per Acre	GPCD	GPAD	Acres	Population	Mean Daily Flow	Acres	Population	Mean Daily Flow	Acres	Population	Mean Daily Flow
PAUWELA	Residential	13	140	1,800	30.0	390	0.0540	60.0	780	0.1080	82.8	1,076	0.1490
	Agricultural	-	-	4,000	71.8	-	0.2872	143.5	-	0.5744	205.0	-	0.8200
	SUB TOTAL	-	-	-	101.8	390	0.3412	203.5	780	0.6824	287.8	1,076	0.9690
ULUMALU	Agricultural	-	-	4,000	301.0	-	1.2040	602.0	-	2.4080	860.0	-	3.4400
	SUB TOTAL (Pauwela & Ulumalu)	-	-	-	402.8	390	1.5452	805.5	780	3.0904	1147.0	1,076	4.4090
KOKOMO	Rural	5	-	1,800	26.6	133	0.0478	53.2	266	0.0956	75.9	380	0.1366
	TOTAL	-	-	-	429.4	523	1.5930	858.7	1046	3.1960	1222.9	1,456	4.5456

ADOPTED DESIGN CRITERIA NO. I-23
FOR
HAIKU-MAKAWAO-PUKALANI

AREA	POPULATION		ESTIMATED WATER DEMAND									STORAGE			
			Mean Daily		Max Day		Peak Hourly		Fire Flow		Duration	Fire Flow	Exist.	Peak Flow	New
	1980	1990	1980	1990	1980	1990	1980	1990	1980	1990	Hrs.	Req'd.	Exist.	Req'd.	New
HAIKU SCHOOL	230	460	0.032	0.064	0.048	0.096	0.096	0.192	1,000	1,000	4.0	0.240	-	0.048	-
HAIKU	664	1,328	0.414	0.828	0.494	0.989	0.737	1.474	1,000	1,164	4.6	0.321	0.07	0.368	-
SUB TOTAL	894	1,788	0.446	0.892	0.542	1.085	0.833	1.666	1,000	1,894	5.2	0.591	0.07	0.416	1.0
ULUMALU	-	-	1.204	2.408	1.204	2.408	1.204	2.408	1,000	1,000	4.0	0.240	-	0.601	2.5
PAUWELA	390	780	0.341	0.682	0.368	0.736	0.449	0.898	1,000	1,000	4.0	0.240	0.07	0.224	0.8
SUB TOTAL	390	780	1.545	3.090	1.572	3.144	1.653	3.306	1,000	1,000	4.0	0.240	-	0.826	-
KOKOMO	133	266	0.048	0.096	0.072	0.144	0.144	0.288	1,000	1,000	4.0	0.240	0.10	0.720	-
HALIIMAILE	492	984	0.069	0.139	0.104	0.209	0.207	0.417	1,000	1,000	4.0	0.240	0.047	0.104	-
MAKAWAO	3,154	6,308	0.445	0.890	0.667	1.335	1.335	2.670	1,788	2,530	10.0	1.518	0.30	0.667	1.5
PUKALANI	6,073	12,146	1.023	2.045	1.534	3.068	3.069	6.135	2,500	3,190	10.0	1.914	1.05	1.532	3.0
SUB TOTAL	9,719	19,438	1.537	3.074	3.025	4.756	4.755	9.510	-	-	-	-	-	-	-
TOTAL	11,136	22,272	3.576	7.152	5.211	9.129	7.385	14.770	-	-	-	-	-	-	-

NOTE: Mean Daily, Max. Daily, and Peak Hourly flows in MGD; Fire Flow in GPM:
Storage for Peak Flow based on 6 Hours.

Sterns & MacDonald state that: "Anywhere east of Maliko Gulch and along the north and east slopes, wells drilled to shallow depths below the basal water table and also Maui-type wells, will recover ample water of excellent quality." The costs involved in the development of these sources for servicing the Makawao-Pukalani areas are considered to be high and mandate that consideration be given to the diversion and treatment of water presently being transported to this area by the Wailoa Ditch System.

The Wailoa System (as per Sterns & MacDonald) has a capacity of approximately 163 MGD. At times of low flow during periods of dry weather, the volume of flow has been estimated at 22 MGD. With the maximum daily demand for this study area estimated to be 9 MG for year 1990, the Board of Water Supply is reviewing the feasibility of emergency programs which would provide for this domestic requirement during periods of dry weather.

Chemical analyses of water samples taken from the ditch are illustrated on Table III-3, Section III. A review of this analyses as related to a listing of allowable concentrations of common constituents as stipulated by the U. S. Public Health Standards Table III-2, Section III denotes turbidity as the main constituent to be reduced by treatment.

It is proposed that the treatment be accomplished by operations which include coagulation, flocculation, filtration and chlorination. The removal of colloidal and finely divided suspended matter can be effected in manufacturers pre-designed and/or pre-packaged units which reduce the turbidity to 5 units or less prior to filtration.

The utilization of alum as the coagulating agent and pH adjustment achieved with lime is anticipated. Filtration is to be completed using gravity rapid sand filter with chlorination being the final step in overall treatment plant operation.

Based on the information available to date, the utilization of treated water from the Wailoa Ditch system, appears to be economically favorable in comparison to the alternative of pumping water from low elevations to service the study area. Should further investigations favor the pumping alternatives in the future, the Water Development Plan for the study area may easily be adjusted by increasing the size of the transmission main from the well site to the treatment plant below Wailoa Ditch.

The development of high level water confined in the dike complex under the north rift does not appear economical at this time. Efforts to tap this supply by the drilling of a deep well at the Kula pipeline intake have failed and the lack of deep canyons in the area make the recovery of water by tunneling doubtful.

g. Proposed Developments

It is proposed that the Wailoa Ditch System be utilized as the source of water for the study area and that a program for water treatment, as described in Item "f" above, be incorporated into the water development plan. It is also proposed that the water treatment plant be located at an approximate elevation of 1,100 feet and that the Lilikoi Intake be utilized as the point of diversion of water from the Wailoa Ditch.

Schematic diagrams for the proposed water plan are illustrated on Plates 31 and 32 with the development plan for the area shown on Plate 33. It is recommended that development of the overall water plan be carried out in the following stages for each respective area:

(1) Makawao-Kokomo

(a) Stage I of the Makawao-Kokomo area includes the installation of 6,000 linear feet of 12" pipeline to Makawao from the Olinda area. This stage also includes development of the Alelele Pump Station to 4.5 MGD and 6,000 linear feet of 16" pipeline from Kokomo to Makawao.

(b) Stage II of the Makawao-Kokomo area includes the first phase of the proposed water treatment plant (3.5 MG); 9,000 linear feet of 20" pipeline from the treatment plant to Kokomo; 6,000 linear feet of 12" pipeline at Makawao and a 1.5 MG storage tank at Makawao.

(c) Stage III of the Makawao-Kokomo area provides for the completion of the proposed water treatment plant to 7.5 MGD capacity.

(2) Pukalani

(a) Stage I - This phase of the proposed development includes the installation of 8,000 linear feet of 16" pipeline from Makawao to Pukalani, a 1.0 MG storage tank (Elev. 1,673) at Pukalani near Haleakala Highway, and approximately 1,000 feet of 12" pipeline from the 1.0 MG storage tank to the 16" line from Makawao.

(b) Stage II - This phase includes the installation of 5,000 linear feet of 12" pipeline at Pukalani and a 0.5 MG storage tank at elevation 1422 feet along Haleakala Highway.

(c) Stage III - This phase provides for a 1.0 MG storage tank at Pukalani, 5,000 linear feet of 8" pipeline and 14,000 feet of 12" pipeline within Pukalani, a 0.5 MG storage tank, 4,000 linear feet of 8" pipeline and a 0.3 MG storage tank above Pukalani.

(3) Haiku

(a) Stage I - The initial stage of the Haiku development includes 6,000 linear feet of 8" pipeline from Haiku to Haiku School and an 8" pipeline approximately 6,000 linear feet long from the treatment plant to PB tank at Haiku.

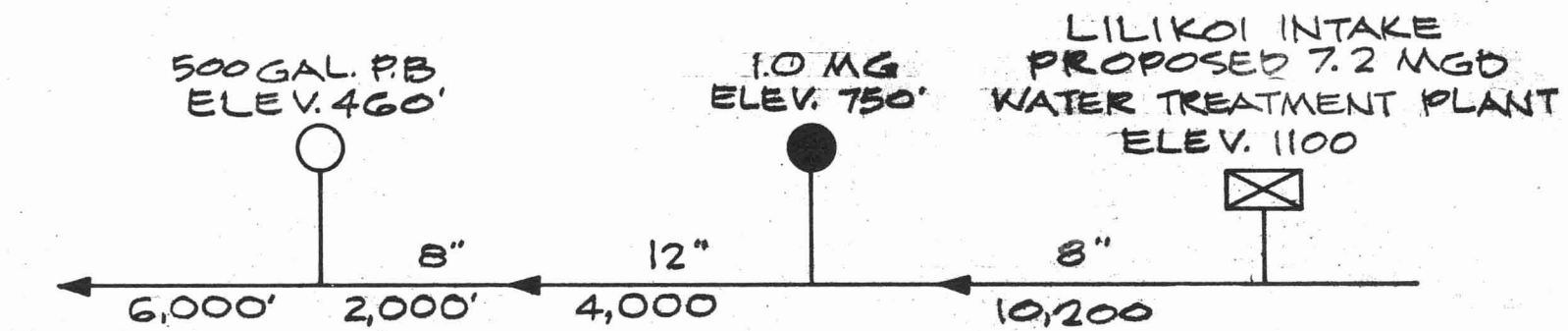
(b) Stage II - This stage includes 4,000 linear feet of 12" pipeline from the area above Haiku to lower Haiku and approximately 6,000 linear feet of 8" pipeline within Haiku.

(c) Stage III - This stage includes 3,000 linear feet of 8" pipeline below Haiku and a 1.0 MG storage tank above Haiku.

(4) Pauwela

(a) Stage I - This phase includes 5,000 linear feet of 12" pipeline leading into Pauwela and 7,000 linear feet of 8" pipeline to Pauwela.

(b) Stage II - This stage includes a 0.5 MG storage tank above Pauwela and 12,000 linear feet of 12" pipeline leading from Kokomo, Ulumalu and Pauwela.

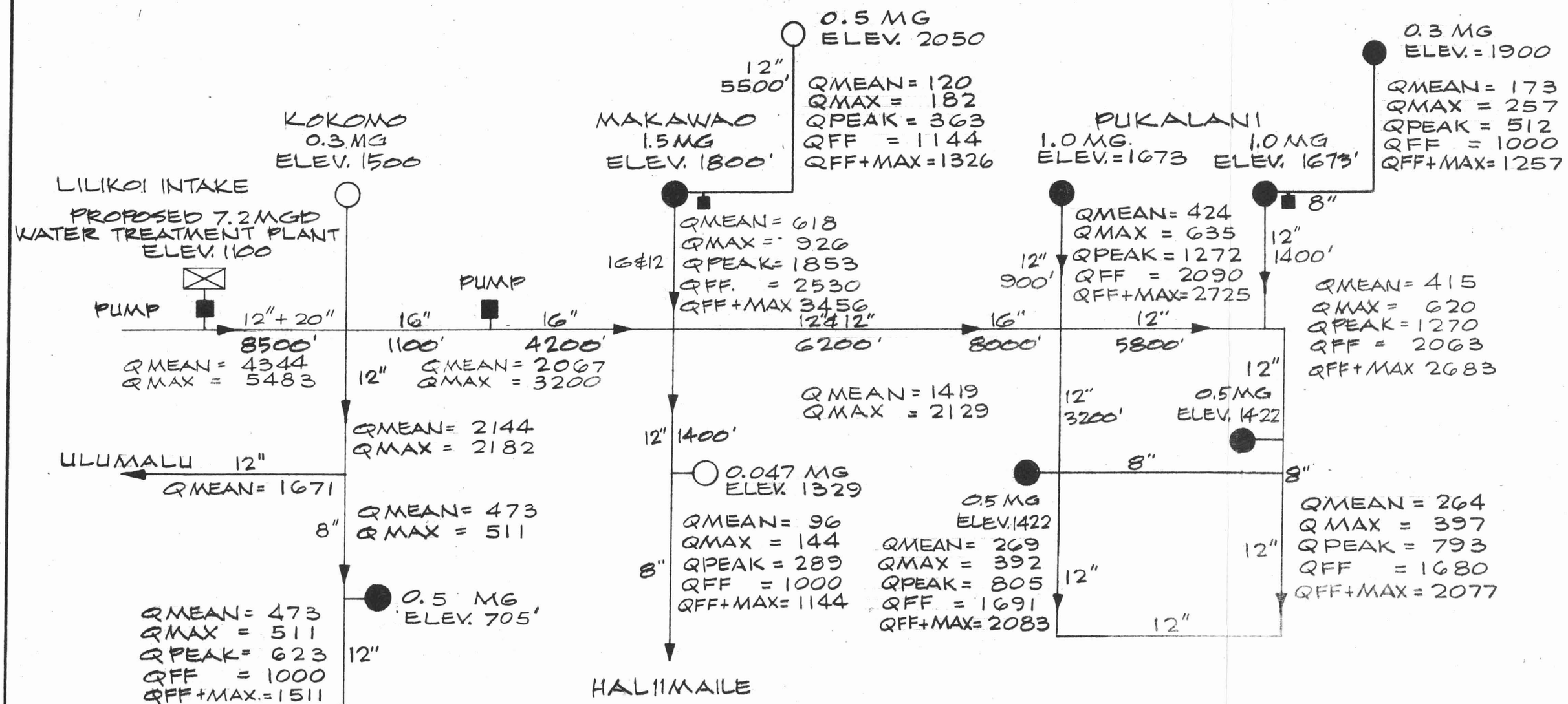


NOTE: FLOWS IN GPM

COUNTY OF MAUI
WATER MASTER PLAN
SCHEMATIC DIAGRAM FOR
WATER SYSTEM PROPOSAL
FOR
HAIKU

R. M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 31



NOTE: FLOWS IN GPM

COUNTY OF MAUI
WATER MASTER PLAN
SCHEMATIC DIAGRAM FOR
WATER SYSTEM PROPOSAL
FOR
MAKAWAO TO PUKALANI

R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS

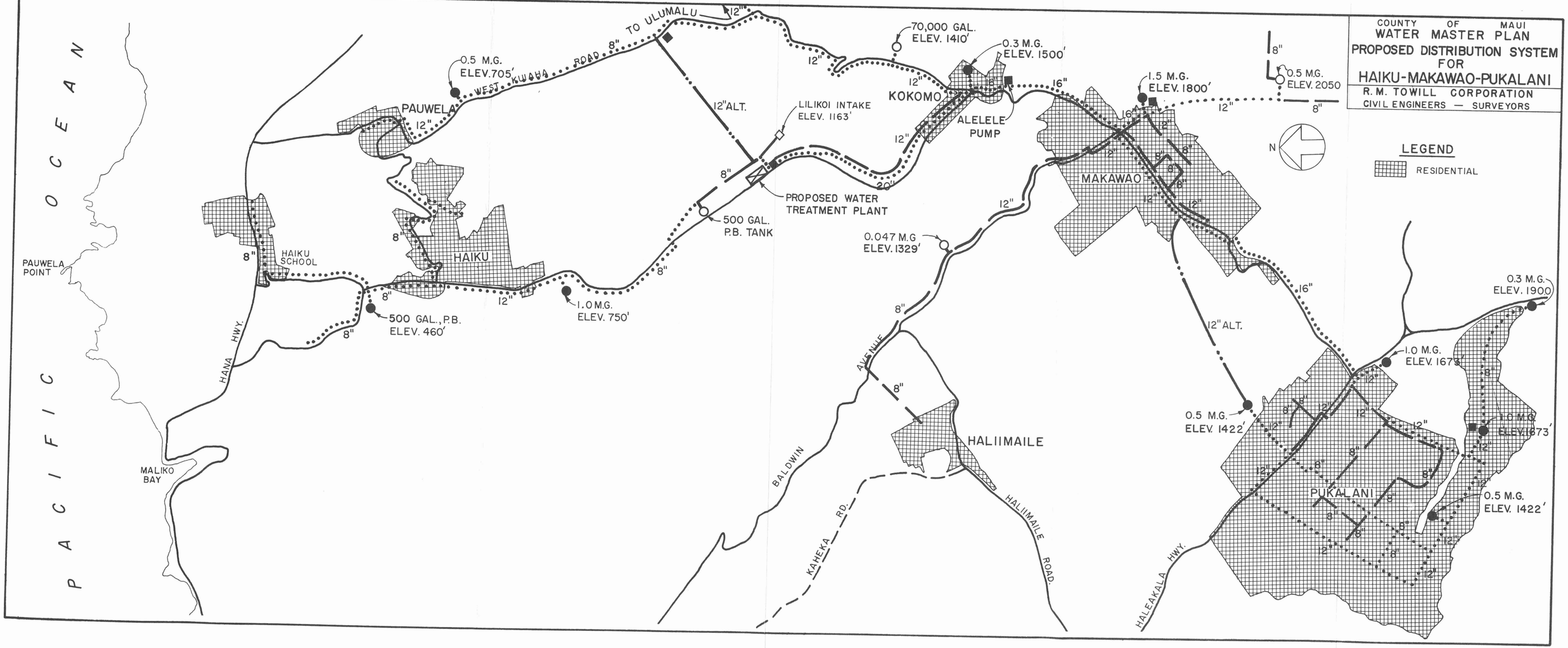

COUNTY OF MAUI
WATER MASTER PLAN
PROPOSED DISTRIBUTION SYSTEM FOR
HAIKU-MAKAWAO-PUKALANI
R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS
LEGEND
RESIDENTIAL
N
PACIFIC OCEAN
PAUWELA POINT
MALIKO BAY
HANA HWY.
TO ULUMALU
WEST KUAHA ROAD
0.5 M.G. ELEV. 705'
PAUWELA
HAIKU SCHOOL
HAIKU
500 GAL., P.B. ELEV. 460'
1.0 M.G. ELEV. 750'
12" ALT.
LILIKOI INTAKE ELEV. 1163'
PROPOSED WATER TREATMENT PLANT
500 GAL. P.B. TANK
70,000 GAL. ELEV. 1410'
KOKOMO
0.3 M.G. ELEV. 1500'
ALELELE PUMP
0.047 M.G ELEV. 1329'
BALDWIN AVENUE
KAHEKA RD.
HALIIMAILE
HALIIMAILE ROAD
1.5 M.G. ELEV. 1800'
0.5 M.G. ELEV. 2050
MAKAWAO
12" ALT.
0.3 M.G. ELEV. 1900
1.0 M.G. ELEV. 1673'
0.5 M.G. ELEV. 1422'
PUKALANI
1.0 M.G. ELEV. 1673'
0.5 M.G. ELEV. 1422'
HALEAKALA HWY.

PLATE 33

6. Hana

a. Limits of Study

The Hana study area located on the easterly end of the island comprises 450 acres of land between the north side of Waihonu Stream and the south portion of Hala Grove. The limits of study for this area are illustrated on Plate 34.

b. Economic Conditions

Presently, the basic source of economy for the area is the Hana Ranch and related ranching operations. This small resort ranching community provides a remote secluded country-type atmosphere for the visiting tourists. Improved roads and water facilities, the development of the State Park, and the preservation of historical monuments in the area could encourage the development of a sound tourist industry.

c. Land Use and Water Demand Areas

The county's General Plan for development of the study area is illustrated on Land Use Map, Plate 34. Table I-24 lists the number of acres allotted for each type of zoning classification. The water demand areas for this location are illustrated on Plate 35 and listed in tabular form on Table I-25.

d. Existing Facilities

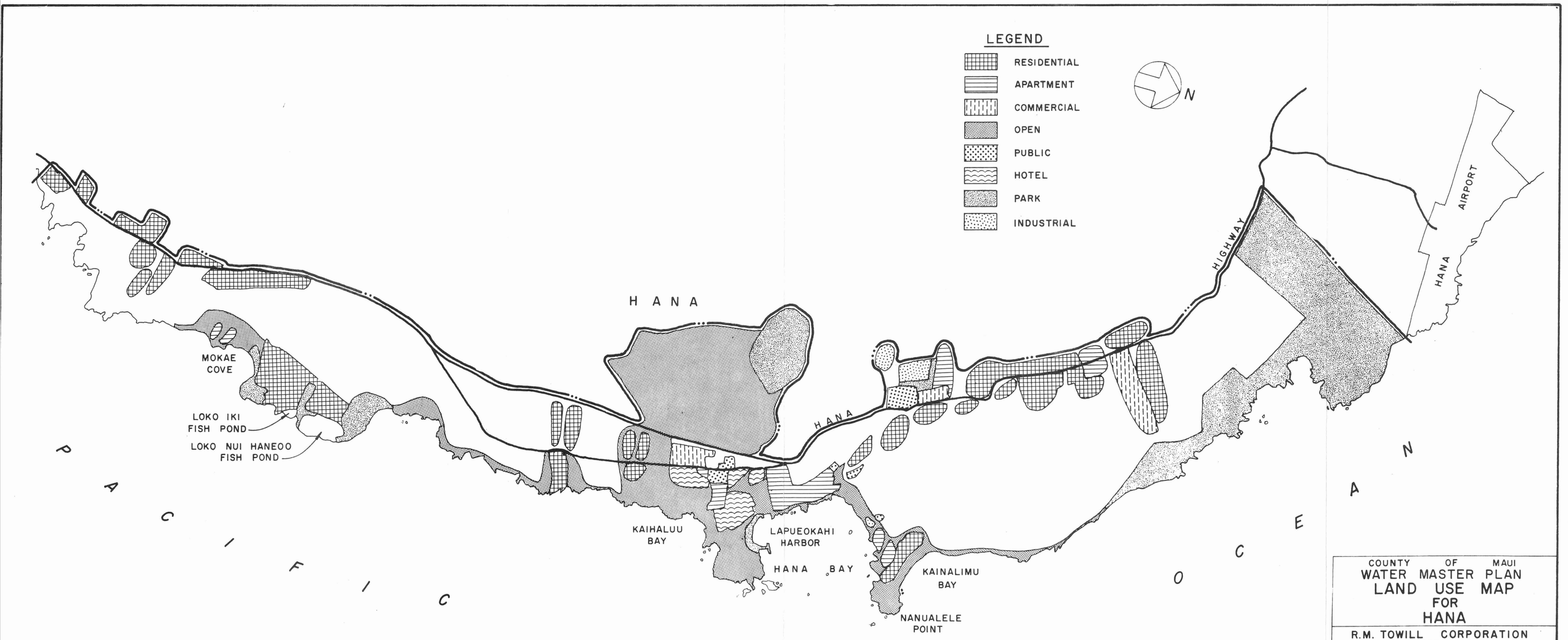
In the Hana area, the water distribution system is essentially a single system serving the town of Hana. The source of water for this system is the Wailua Stream. The water is transported through a 4" transmission pipeline from the Wailua intake to the town of Hana. The existing transmission and distribution system is illustrated on Plate 36.

TABLE NO. I-24

SUMMARY OF ZONING ACREAGE

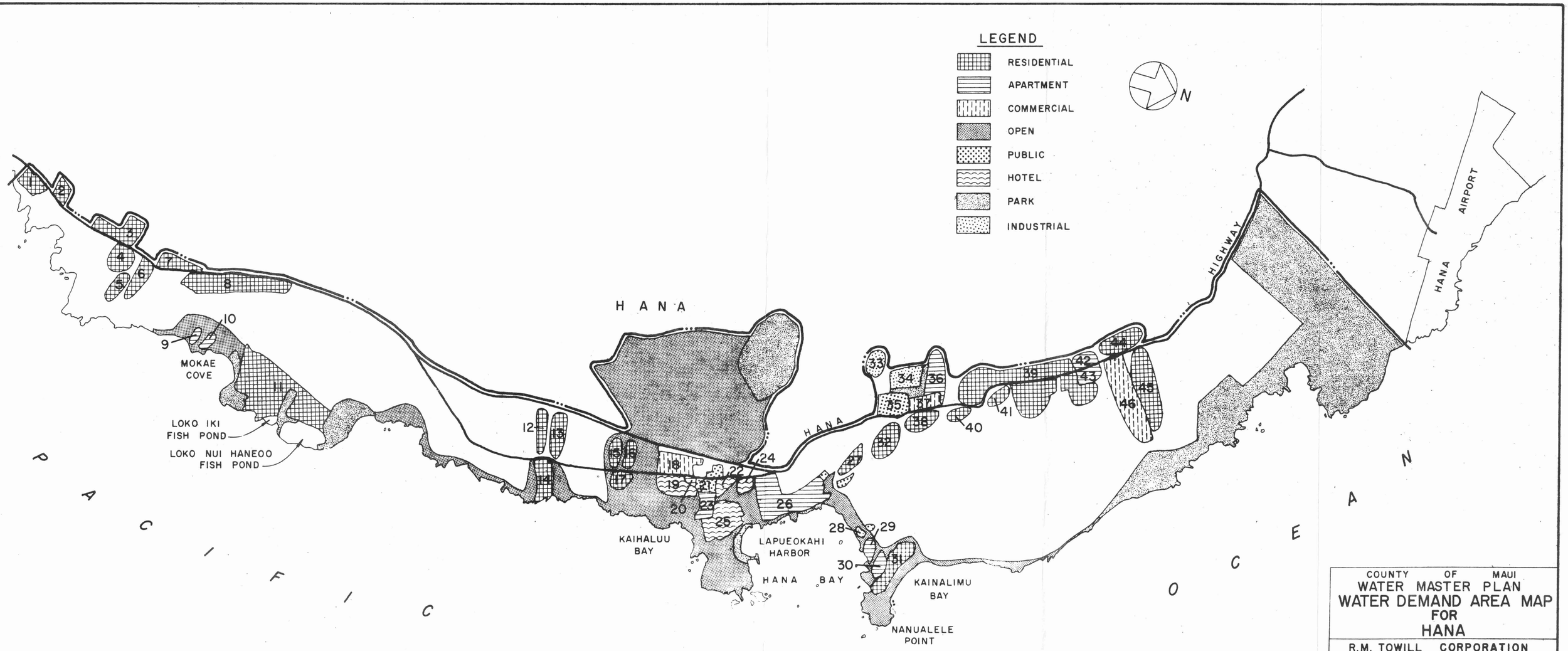
HANA

Land Use	Area in Acres
Residential	289.7
Apartment	66.1
Commercial	16.5
Hotel	28.3
Church	5.2
Medical Center	9.1
School	23.5
Industrial	15.9



COUNTY OF MAUI
WATER MASTER PLAN
LAND USE MAP
FOR
HANA

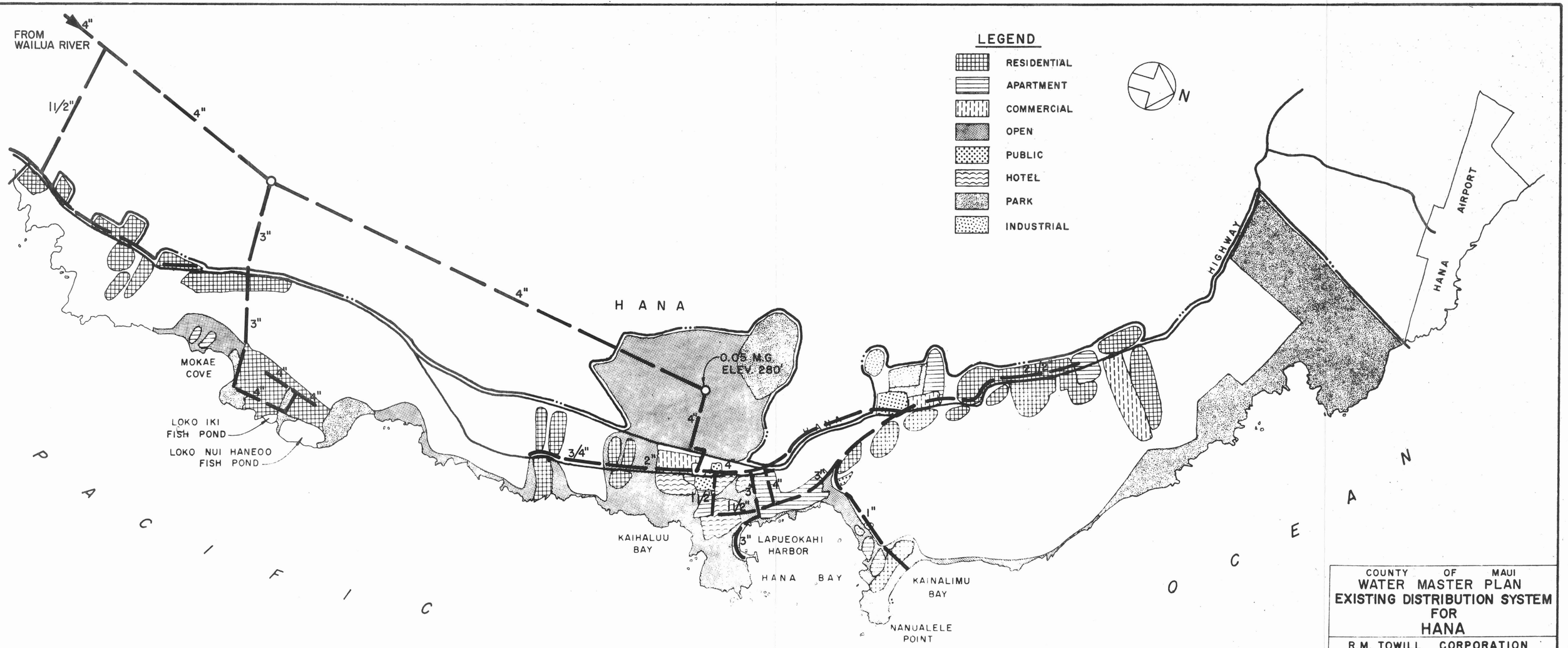
R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS



COUNTY OF MAUI
WATER MASTER PLAN
WATER DEMAND AREA MAP
FOR
HANA

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 35



COUNTY OF MAUI
WATER MASTER PLAN
EXISTING DISTRIBUTION SYSTEM FOR HANA

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 36

TABLE NO. I-25

AREA DESIGNATION/LAND USE/ACREAGE

HANA

Area No.	Land Use	Acreage	Area No.	Land Use	Acreage
1	Residential	6.6	24	Hotel	3.6
2	Residential	3.2	25	Hotel	13.2
3	Residential	10.5	26	Apartment	27.8
4	Residential	8.2	27	Residential	4.1
5	Residential	4.4	28	Industrial	1.3
6	Residential	8.2	29	Apartment	3.2
7	Residential	6.7	30	Apartment	4.0
8	Residential	23.0	31	Residential	9.8
9	Apartment	2.2	32	Residential	10.2
10	Apartment	0.4	33	Industrial	5.5
11	Residential	49.5	34	Industrial	9.1
12	Residential	5.8	35	Medical Center	9.1
13	Residential	7.6	36	Apartment	11.4
14	Residential	7.6	37	Commercial	5.5
15	Residential	5.5	38	Residential	8.0
16	Residential	3.2	39	Residential	60.0
17	Residential	5.3	40	Residential	5.1
18	Commercial	11.0	41	Residential	5.3
19	Hotel	8.6	42	Apartment	4.7
20	Apartment	1.8	43	Apartment	4.4
21	Church	5.2	44	Residential	10.7
22	Hotel	2.9	45	Residential	21.2
23	Apartment	6.2	46	School	23.5

The distribution pipelines in Hana are made up of lines of 3/4" to 4" in diameter. Calculations performed to determine the capacity of the 4" line indicate that it is capable of supplying approximately 250,000 gallons per day to the town of Hana. Based on the 1970 census, it is estimated that the Hana system has a demand of 140,000 gallons per day. The Wailua Stream is erratic and at times past experience has indicated periods of no flow at the location of the intake.

e. Future Consumption

The projected mean flow for 1980 in the Hana area is estimated at 0.517 MGD and the estimated mean flow for 1990 is 1.630 MGD (Table I-26). From Table I-28, the estimated maximum daily water demands for 1980 and 1990 are 0.858 MGD and 2.45 MGD, respectively. The peak hourly flows are estimated at 1.716 MGD and 4.896 MGD for 1980 and 1990, respectively, and are tabulated in Table I-28.

f. Source

The preliminary report on the "Water Resources of Northeast Maui," prepared by the U.S. Geological Survey, indicated that there is an ample amount of ground water located in the Hana area. This seems to be borne out since Hana Ranch Company has drilled an 8" well 280 feet deep about one mile from shore in the Hana area.

TABLE NO. I-26

ADOPTED DESIGN CRITERIA
FOR
HANA

Area	Land Use	Per Acre	GPCD	GPAC	1980 35% of Max Development			1990 70% of Max Development			Max Development (2,000)		
					Acres	Population	Flow	Acres	Population	Flow	Acres	Population	Flow
	Residential	13	140	1,800	101.4	1,318	0.1825	202.9	2,636	0.3650	289.7	3,766	0.5182
	Apartment	40	140	5,600	23.1	925	0.1294	46.2	1,850	0.2587	66.1	2,644	0.3702
	Commercial	-	-	6,000	5.8	-	0.0348	11.6	-	0.0696	16.5	-	0.0990
	Hotel	-	-	17,000	9.9	-	0.1683	19.8	-	0.3366	28.3	-	0.4811
	Public	-	-	1,700	13.2	-	0.0224	26.4	-	0.0449	37.8	-	0.0643
	Industrial			6,000	5.6	-	0.0336	11.1	-	0.0666	15.9	-	0.0954
	SUM				159.0	2,243	0.5710	318.0	4,486	1.1414	454.3	6,410	1.630

TABLE NO. I-27
ADOPTED DESIGN CRITERIA
FOR
HANA

Area	Land Use	Per Acre	GPCD	GPAD	1980 35% of Max Development Acres	1980 35% of Max Development Population	1980 35% of Max Development Flow	1990 70% of Max Development Acres	1990 70% of Max Development Population	1990 70% of Max Development Flow	Max Development (2,000) Acres	Max Development (2,000) Population	Max Development (2,000) Flow
# 1 to #11	Residential	13	140	1,800	42.1	547	0.0758	84.2	1,094	0.1516	120.3	1,564	0.2165
	Apartment	40	140	5,600	0.9	36	0.0051	1.8	72	0.0102	2.6	104	0.0146
	SUBTOTAL	-	-	-	43.0	583	0.0809	86.0	1,166	0.1618	122.9	1,668	0.2311
#12 to #17	Residential	13	140	1,800	12.3	160	0.0221	24.6	320	0.0441	35.0	455	0.0630
#18 to #26	Apartment	40	140	5,600	12.5	500	0.0702	25.0	1,000	0.1403	35.8	1,432	0.2005
	Commercial	-	-	6,000	3.9	-	0.0234	7.8	-	0.0468	11.0	-	0.0660
	Hotel	-	-	17,000	9.9	-	0.1683	19.8	-	0.3366	28.3	-	0.4811
	Public	-	-	1,700	1.8	-	0.0031	3.6	-	0.0061	5.2	-	0.0088
	SUBTOTAL	-	-	-	28.1	500	0.2650	56.2	1,000	0.5298	80.3	1,432	0.7564
#27 to #38	Residential	13	140	1,800	11.2	146	0.0202	22.5	293	0.0405	32.1	417	0.0578
	Apartment	40	140	5,600	6.5	260	0.0364	13.0	520	0.0728	18.6	744	0.1042
	Commercial	-	-	6,000	1.9	-	0.0114	3.9	-	0.0228	5.5	-	0.0330
	Industrial	-	-	6,000	5.6	-	0.0336	11.1	-	0.0666	15.9	-	0.0954
	Public	-	-	1,700	3.2	-	0.0054	6.4	-	0.0109	9.1	-	0.0155
	SUBTOTAL	-	-	-	28.4	402	0.1070	56.9	813	0.2136	81.2	1,161	0.3059
#39 to #46	Residential	13	140	1,800	35.8	465	0.0644	71.6	931	0.1289	102.3	1,330	0.1841
	Apartment	40	140	5,600	3.2	128	0.0179	6.4	256	0.0358	9.1	364	0.0510
	Public	-	-	1,700	8.2	-	0.0140	16.4	-	0.0280	23.5	-	0.0400
	SUBTOTAL	-	-	-	47.2	593	0.0963	94.4	1,187	0.1927	134.9	1,694	0.2751
	TOTAL	-	-	-	159.0	2,243	0.5710	318.0	4,486	1.1414	454.3	6,410	1.630

TABLE NO. I-28

ADOPTED DESIGN CRITERIA
FOR
HANA

AREA	POPULATION		ESTIMATED WATER DEMAND								STORAGE				
			Mean Daily		Max Day		Peak Hourly		Fire Flow		Duration	Fire Flow Req'd	Exist.	Peak Flow Req'd	New
	1980	1990	1980	1990	1980	1990	1980	1990	1980	1990	Hours				
# 1 to #11	583	1,166	0.081	0.231	0.122	0.347	0.244	0.694	1,000	1,080	4.2	0.272	-	0.389	0.3
#12 to #17	160	320	0.022	0.063	0.033	0.095	0.066	0.190	1,000	1,000	4.0	0.240	-	0.360	-
#18 to #26	500	1,000	0.265	0.756	0.398	1.134	0.796	2.268	1,000	1,000	4.0	0.240	0.5	0.360	1.0
#27 to #38	406	813	0.107	0.306	0.161	0.459	0.322	0.918	1,000	1,000	4.0	0.240	-	0.360	1.0
#39 to #46	593	1,187	0.096	0.275	0.144	0.413	0.288	0.826	1,000	1,050	4.3	0.282	-	0.393	-
TOTAL	2,242	4,486	0.571	1.630	0.858	2.448	1.716	4.896	5,000	5,170	-	1.274	0.5	1.862	2.3

NOTE: Mean Daily, Max. Daily, and Peak Hourly flows in MGD; Fire Flow in GPM

g. Proposed Development

The existing water distribution system is incapable of handling any of the projected demands for 1980 and 1990, and presently, is incapable of delivering sufficient flow for fire. Development of the County system in Hana is proposed in three stages. In the first two stages, the development will be located in the Hana Town Area while the area south of Hana will utilize the old water system which has the Wailua River as its source. The proposed plan for development is illustrated schematically on Plates 37 and 38 with the plan for development shown on Plate 39.

The development of Hana's water distribution system is proposed to be implemented in three stages.

(1) Stage I

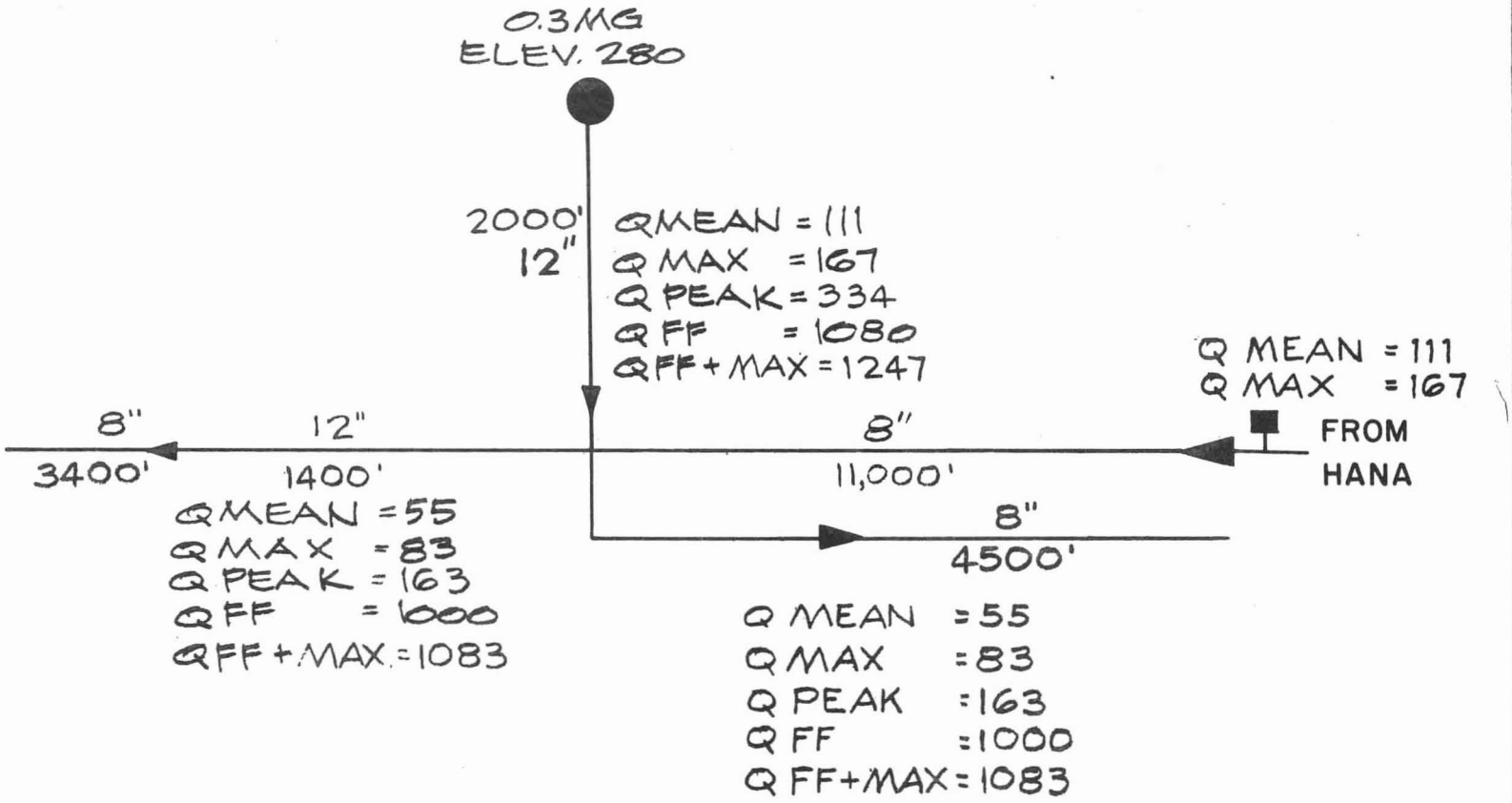
The first stage of development includes:

(a) Development of a 1.0 MG well at Waikiu;

(b) Development of a 0.5 MG storage tank at Waikiu;

(c) Installation of 2,400 feet of 12" pipeline from the tank to Hana Highway, 1,000 feet of 8" pipeline along Hana Highway to Hana School and 5,000 feet of 12" pipeline towards the Hana town area.

(d) This phase includes 4,500 feet of 8" pipeline to Hana; 2,000 feet of 12" pipeline and 3,000 feet of 8" pipeline within Hana.



NOTE: FLOWS IN GPM

COUNTY OF MAUI
WATER MASTER PLAN
SCHEMATIC DIAGRAM FOR
WATER SYSTEM PROPOSAL
FOR
HANA AT MOKAE

R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS

PLATE 37

(2) Stage II

Stage II includes:

(a) Development of a 1.0 MG well above Hana;

(b) Development of a 1.0 MG storage tank above Hana; and

(c) Installation of 2,000 feet of 12" pipeline from the tank to Hana.

(3) Stage III

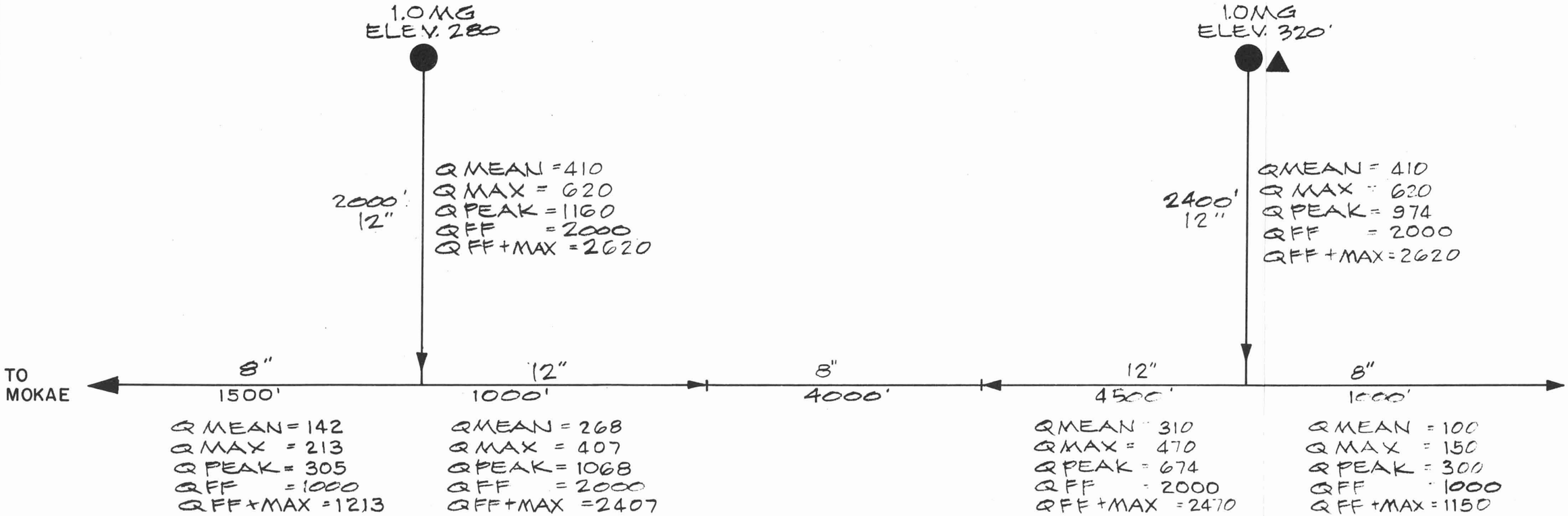
The final phase includes:

(a) Development of a 0.5 MG storage tank at Waikui;

(b) Installation of 11,000 feet of 8" pipeline at Mokae;

(c) Development of a 0.25 MG pump on the 8" pipeline to Mokae and a 0.3 MG storage tank above Mokae; and

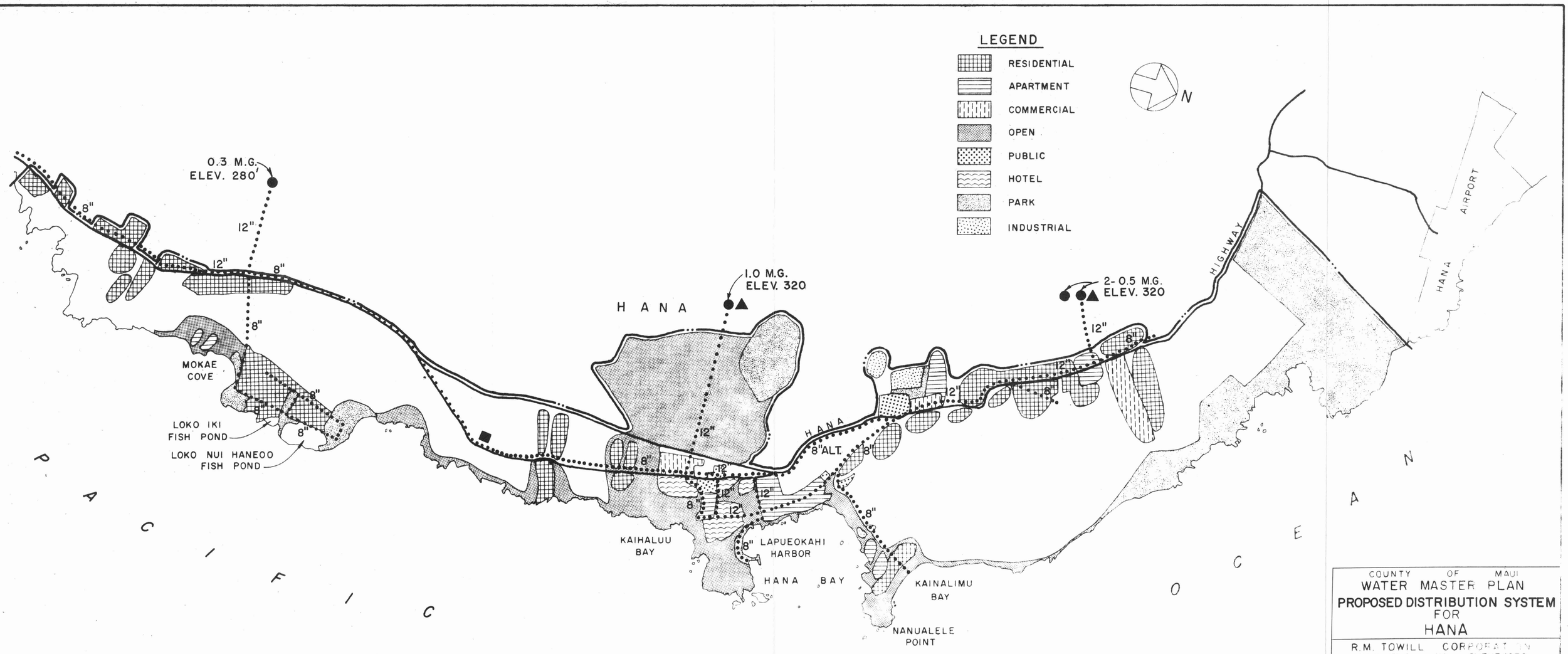
(d) Installation of 2,000 feet of 12" pipeline from the tank to Mokae, 1,400 feet of 12" pipeline approximately 8,000 feet of 8" pipeline at Mokae.



NOTE: FLOWS IN GPM

COUNTY OF MAUI
WATER MASTER PLAN
SCHEMATIC DIAGRAM FOR
WATER SYSTEM PROPOSAL
FOR
HANA

R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS



COUNTY OF MAUI
WATER MASTER PLAN
PROPOSED DISTRIBUTION SYSTEM
FOR
HANA

R.M. TOWILL CORPORATION
CIVIL ENGINEERS - SURVEYORS

PLATE 39

F. INDIVIDUAL AREA OF STUDY - ISLAND OF MOLOKAI

1. Kaunakakai-Pukoo

a. Limits of Study

The Kaunakakai-Pukoo study area, located on the southeasterly shoreline of the Island of Molokai, encompasses 920 acres of land. The limits of study for this area are illustrated on Plates 40, 41, 42 and 43.

b. Economic Conditions

Presently, there is no major source of economy for the area. Small residential communities along the shoreline are primarily dependent upon the pineapple and cattle grazing industries of the island. Future growth of this area is dependent upon the development of a resort industry. Activity toward that direction is not in evidence within the area of study.

c. Land Use and Water Demand Areas

The County's general plan for development of the study area is shown on Land Use Map, Plates 40, 41, 42 and 43. Table I-29 summarizes the number of acres allotted for each type of zoning classification. The water demand areas for this location are illustrated on Plates 44, 45, 46 and 47 and listed in tabular form on Table I-30.

d. Existing Facilities

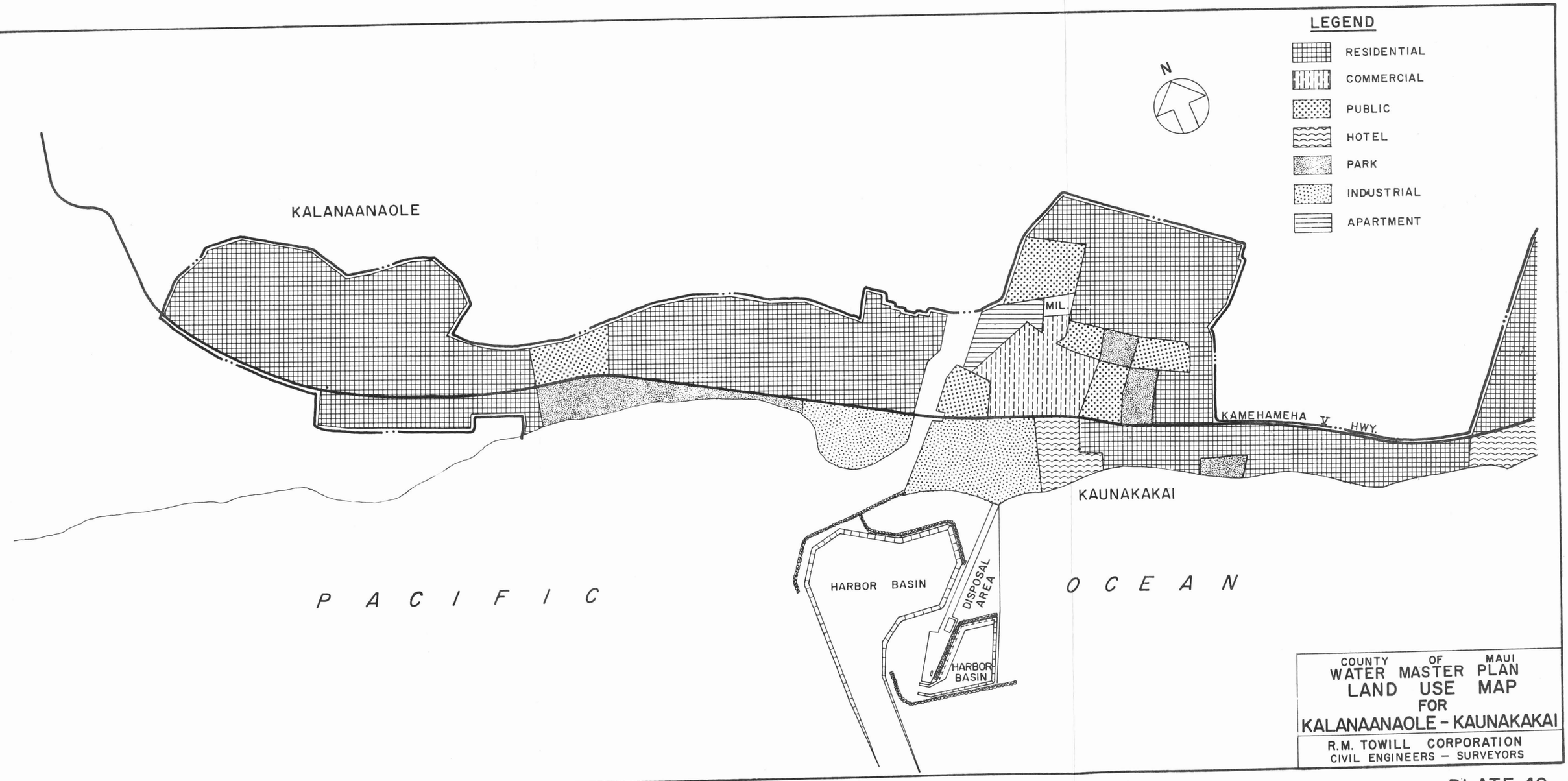
The county of Maui operates two water distribution systems in the study area. One system is the Kaunakakai Distribution System which serves the town of Kaunakakai and its surrounding area. The second system is the Ualapue System which serves the Kamalo-Pukoo and Waialua areas.

TABLE NO. I-29

SUMMARY OF ZONING ACREAGE

KAUNAKAKAI - PUKOO

Land Use	Acreage
Residential	2018.9
Church	21.2
Park	194.2
Industrial	58.4
Hospital	16.5
Apartment	82.1
Civic Center	8.8
Commercial	105.0
Community Center	4.4
School	32.2
Hotel	146.6
Open	3.0
Cemetery	2.0



COUNTY OF MAUI
WATER MASTER PLAN
LAND USE MAP
FOR
KALANAANAOLE - KAUNAKAKAI

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 40

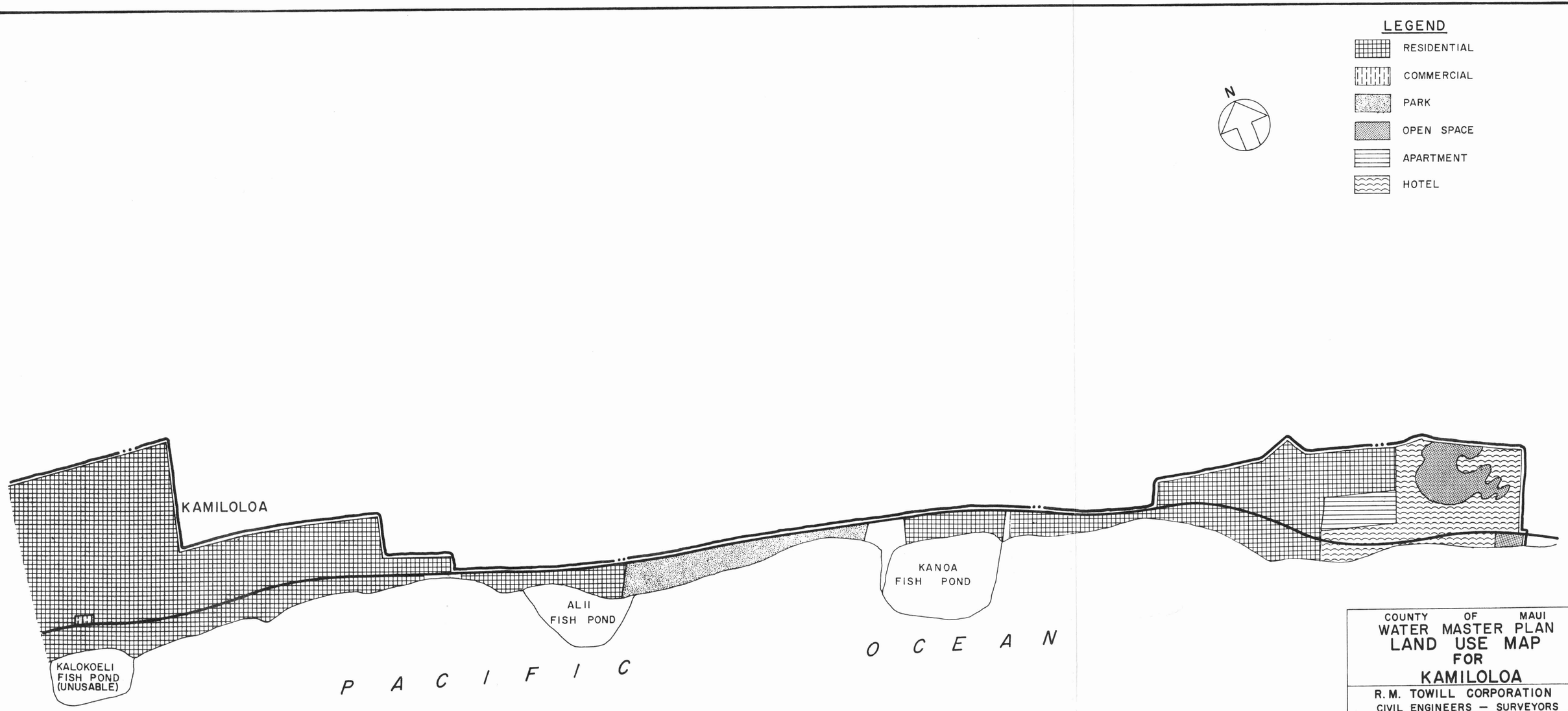
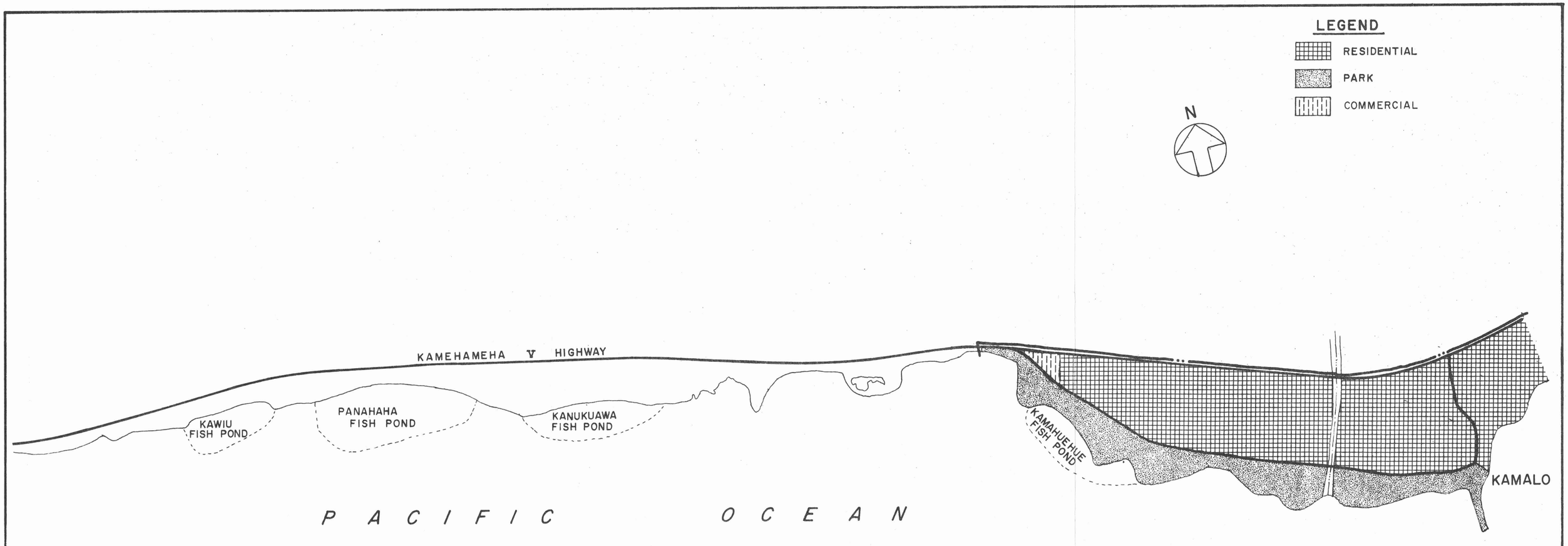

LEGEND
RESIDENTIAL
COMMERCIAL
PARK
OPEN SPACE
APARTMENT
HOTEL
N
KAMILOLOA
KALOKOELI FISH POND (UNUSABLE)
ALII FISH POND
KANOA FISH POND
P A C I F I C
O C E A N
COUNTY OF MAUI
WATER MASTER PLAN
LAND USE MAP
FOR
KAMILOLOA
R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS

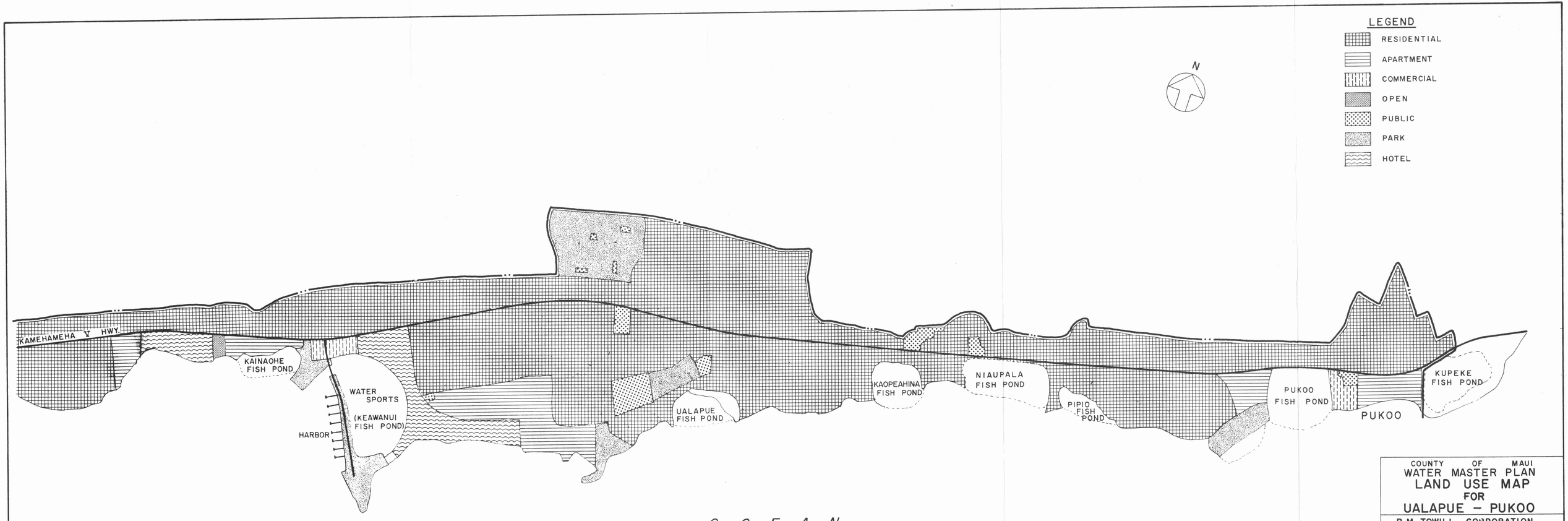
PLATE 41



COUNTY OF MAUI
WATER MASTER PLAN
LAND USE MAP
FOR
KAMALO

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

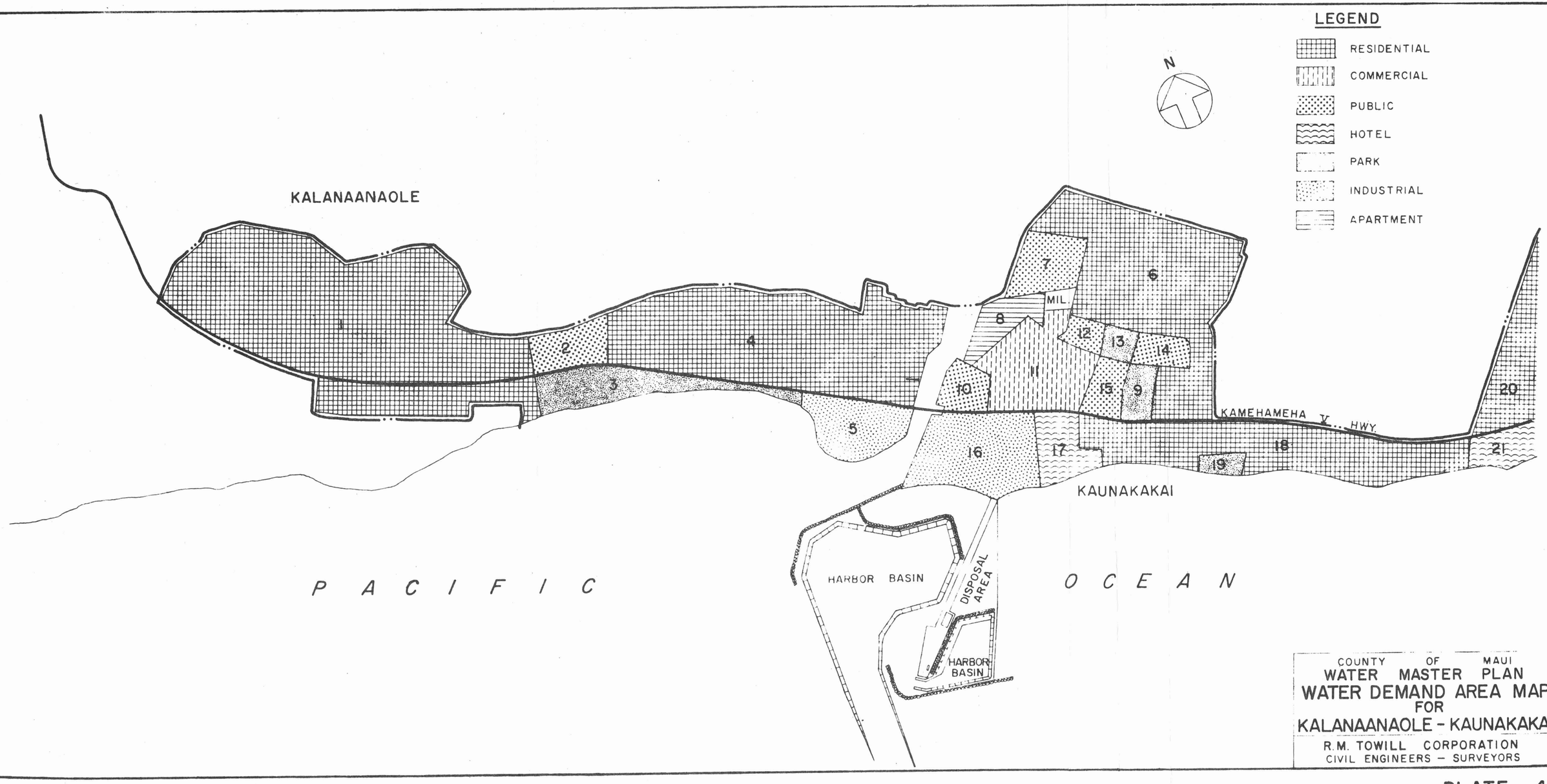
PLATE 42



COUNTY OF MAUI
WATER MASTER PLAN
LAND USE MAP
FOR
UALAPUE – PUKOO

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

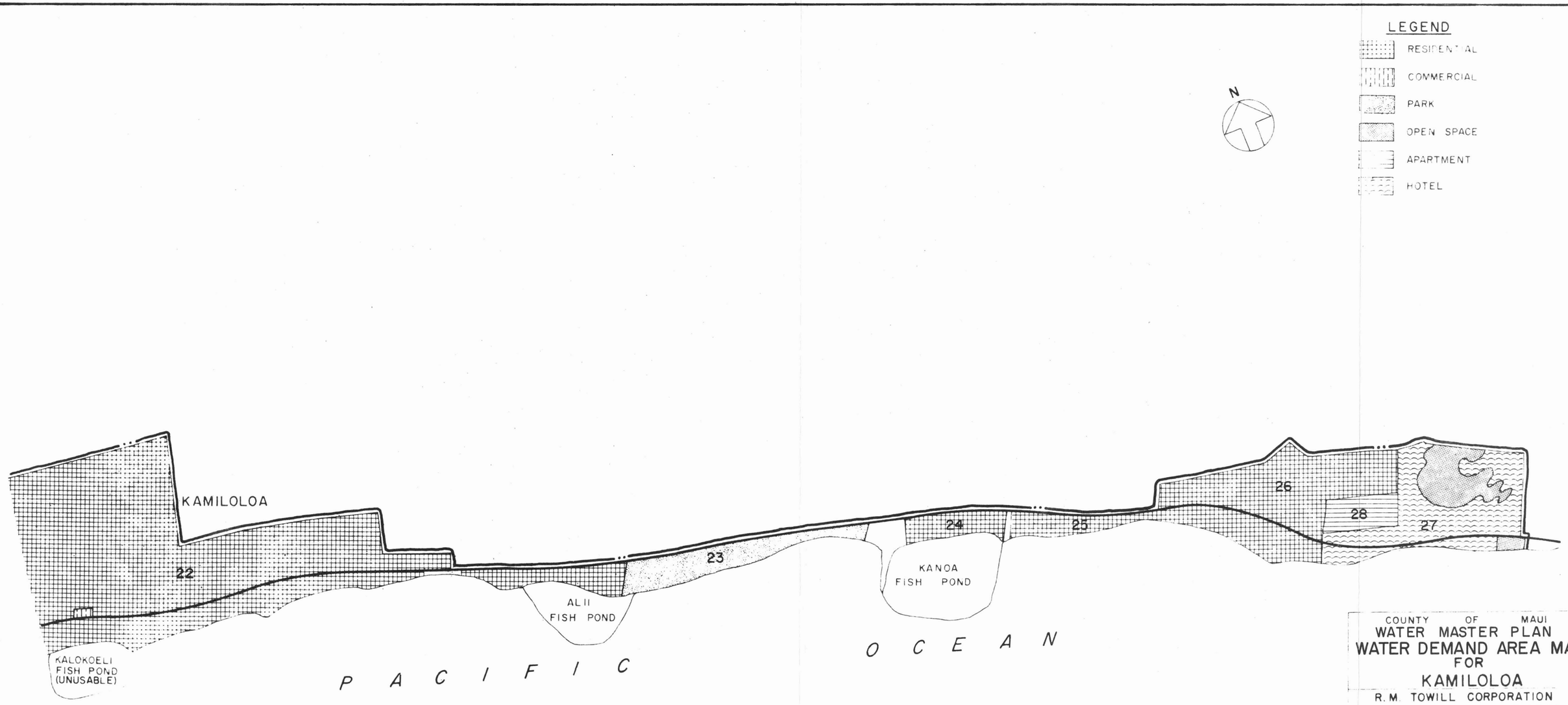
PLATE 43



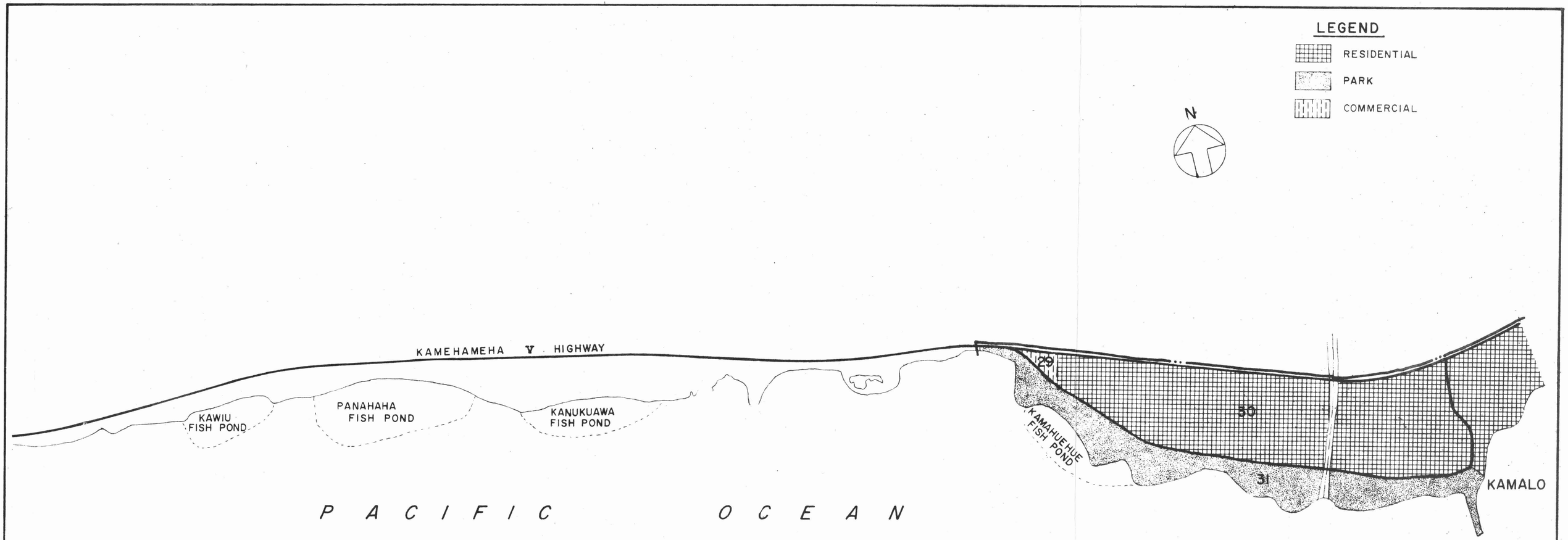
COUNTY OF MAUI
WATER MASTER PLAN
WATER DEMAND AREA MAP
FOR
KALANAANAOLE - KAUNAKAKAI

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 44



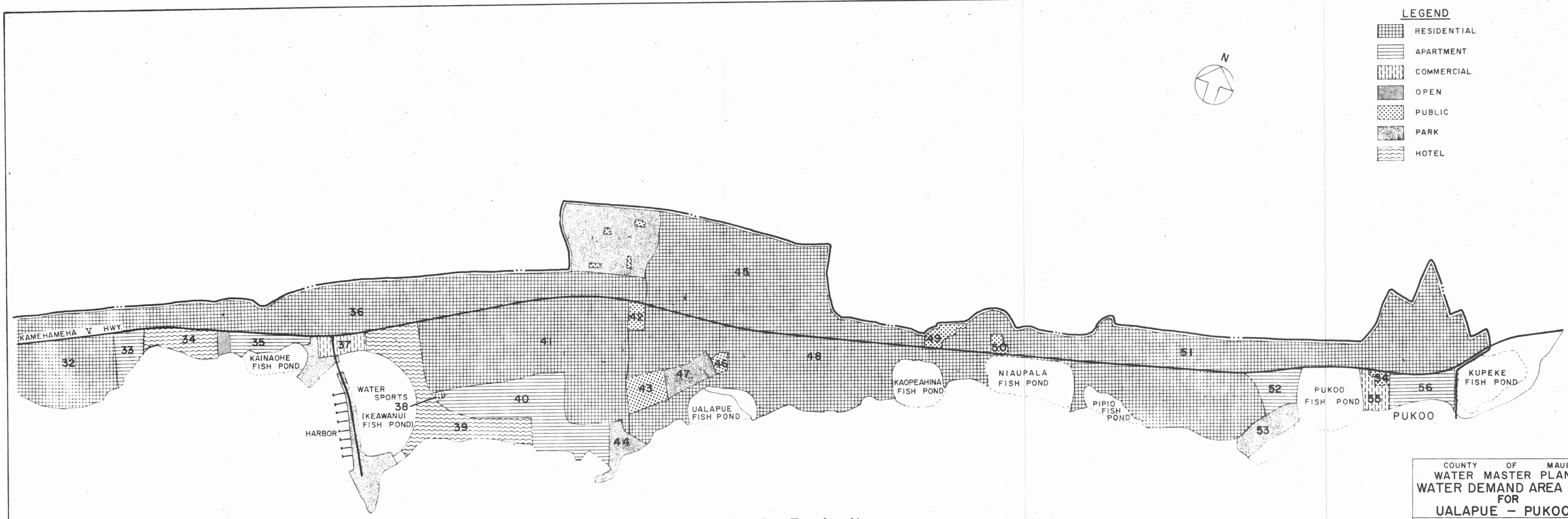
COUNTY OF MAUI
WATER MASTER PLAN
WATER DEMAND AREA MAP
FOR
KAMILOLOA
R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS



COUNTY OF MAUI
WATER MASTER PLAN
WATER DEMAND AREA MAP
FOR
KAMALO

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 46



COUNTY OF MAUI
WATER MASTER PLAN
WATER DEMAND AREA MAP
FOR
UALAPUE – PUKOO
R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 47

TABLE NO. I-30

AREA DESIGNATION/LAND USE/ACREAGE

KAUNAKAKAI - PUKOO

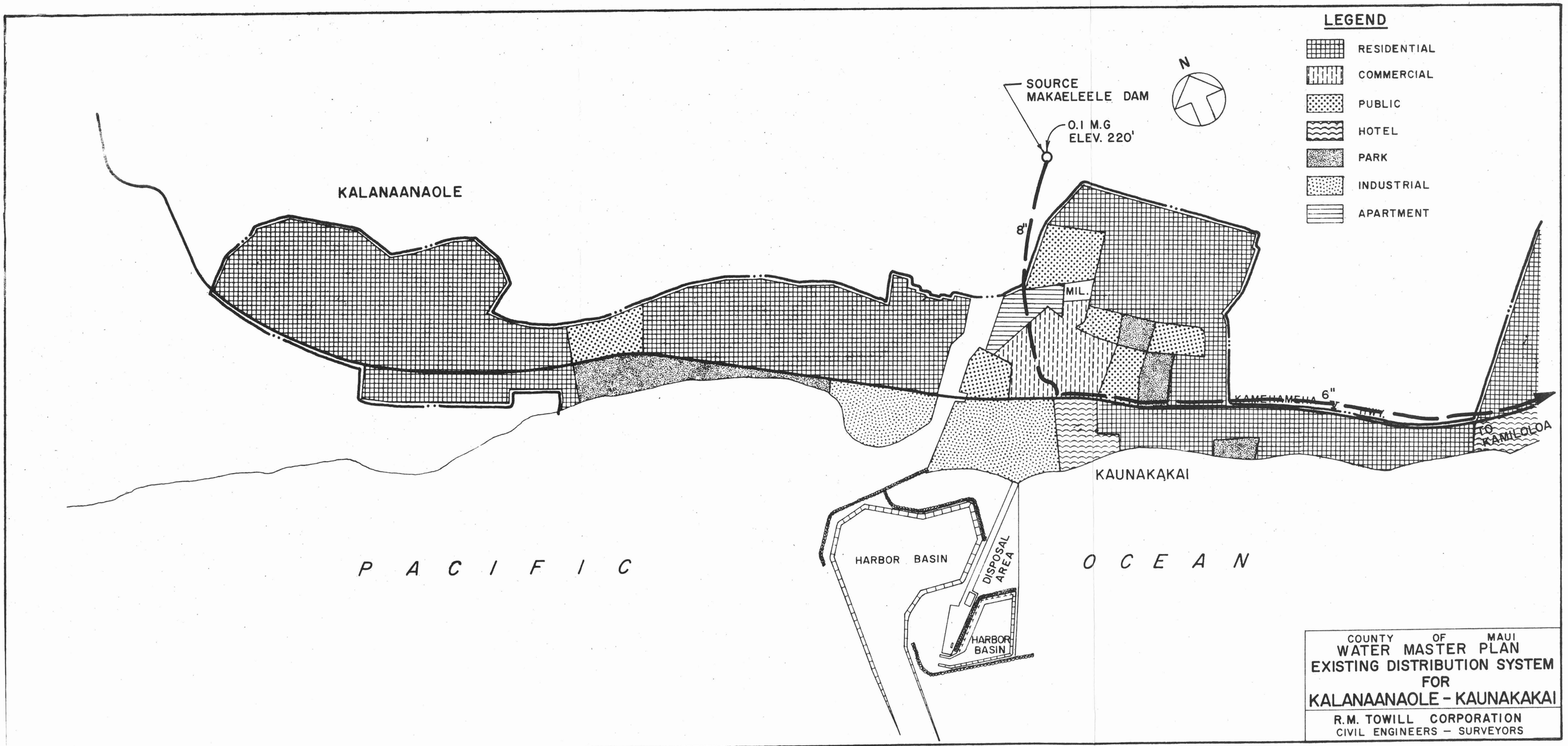
Area No.	Land Use	Acreage
1	Residential	204.0
2	Church	13.6
3	Park	23.4
4	Residential	127.0
5	Industrial	22.8
6	Residential	100.0
7	Hospital	16.5
8	Apartment	12.9
9	Apartment	1.8
10	Civic Center	8.8
11	Commercial	33.2
12	Community Center	4.4
13	Park	3.7
14	School	6.6
15	School	7.8
16	Industrial	35.6
17	Apartment	13.0
18	Residential	70.0
19	Park	3.5
20	Residential	25.8
21	Apartment	16.4
22	Residential	248.8
23	Park	24.0
24	Residential	10.3
25	Residential	15.8
26	Residential	64.2
27	Hotel	38.2
28	Apartment	11.4
29	Commercial	2.2
30	Residential	203.0
31	Park	114.0
32	Residential	51.5
33	Residential	110.0
34	Commercial	40.5
35	Commercial	14.7
36	Residential	50.0
37	Commercial	7.4
38	Open	3.0
39	Hotel	55.4
40	Hotel	53.0
41	Residential	192.0
42	School	4.0
43	School	12.0
44	Park	11.6
45	Residential	150.0
46	Cemetery	2.0
47	Residential	64.0
48	Residential	164.5
49	Church	5.1
50	Church	2.5
51	Residential	168.0
52	Apartment	13.0
53	Park	14.0
54	School	1.8
55	Commercial	7.0
56	Apartment	13.6

These existing systems are illustrated on Plates 48, 49, 50 and 51.

The source of water for the Kaunakakai system is the Makaeleele Dam at Kapuna Springs and the Kawela Well located near the southern coastline of Kawela. The source of the Ualapue system is the Ualapue Well which is a Molokai-type well located approximately 1/2 mile southeast of the town of Ualapue at an elevation of 40 feet. The water distribution system is made up of a system of 4", 6" and 8" pipelines paralleling the southern coastline of Molokai.

The Department of Land and Natural Resources report, "A Domestic Water Plan for Kaunakakai-Pukoo," states that the Kawela Well can supply 430,000 gallons per day. Tests conducted early in 1971 by the Department of Land and Natural Resources estimated a safe yield of 1.0 MGD for the Ualapue Well.

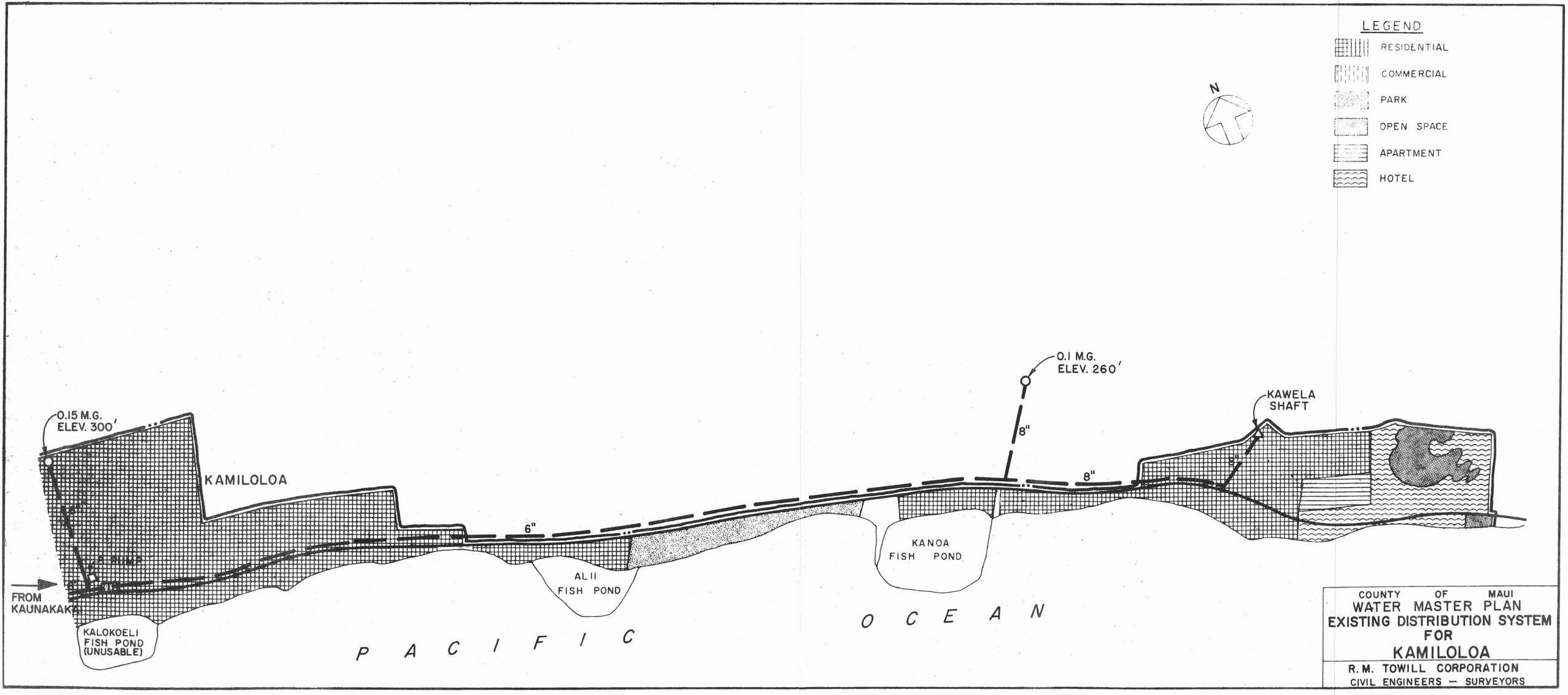
The Department of Land and Natural Resources report, "A Domestic Water Plan," also states that the demand on the Kaunakakai system was 380,000 gallons per day in 1962, and the demand on the Ualapue system was 80,000 gallons per day. It is believed that the demand has not increased significantly based on the 1960-1970 census in which the 1960 population of Molokai was given as 4,744 and that of 1970 as 5,089, an increase of 344 people for the island.



COUNTY OF MAUI
WATER MASTER PLAN
EXISTING DISTRIBUTION SYSTEM
FOR
KALANAANAOLE - KAUNAKAKAI

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

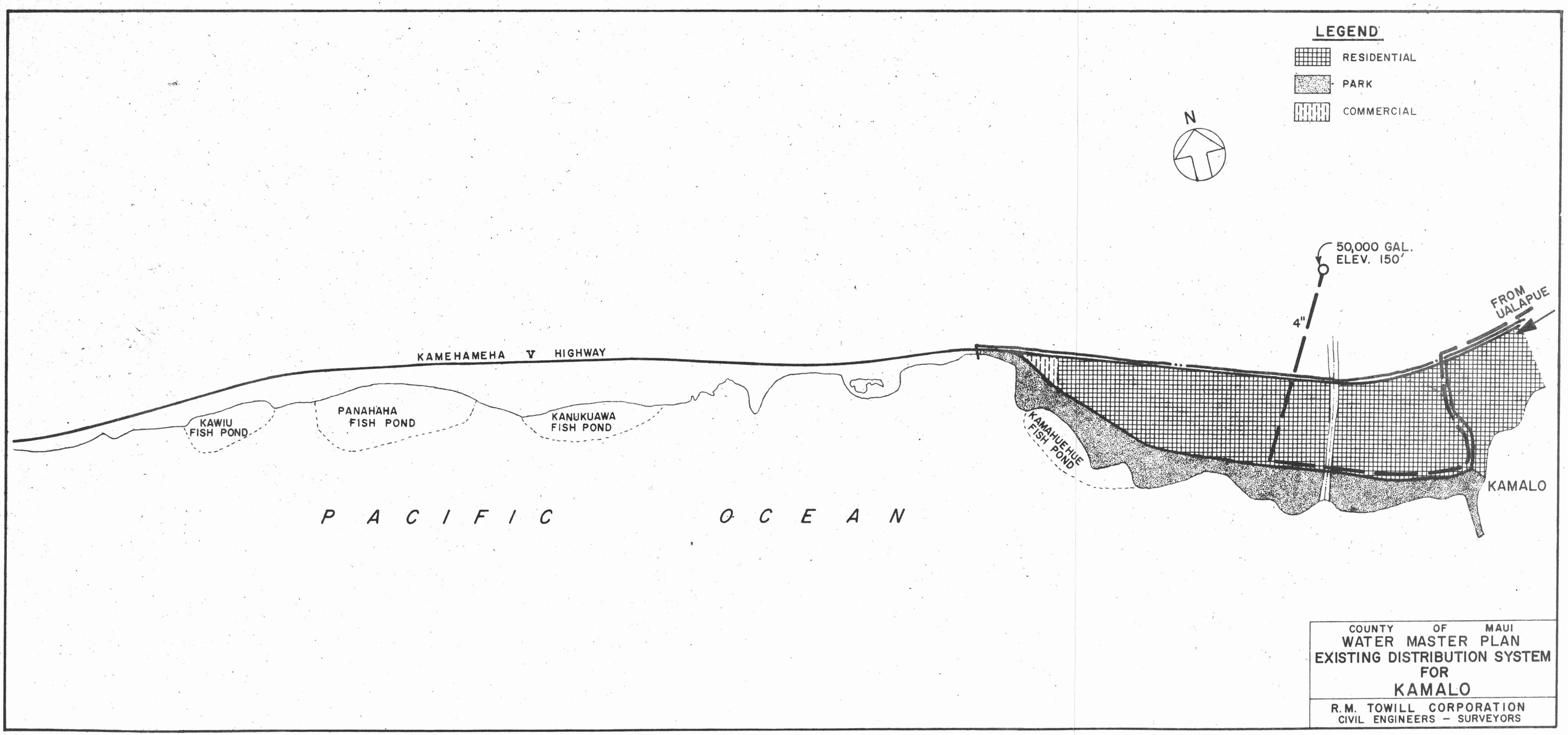
PLATE 48



COUNTY OF MAUI
WATER MASTER PLAN
EXISTING DISTRIBUTION SYSTEM
FOR
KAMILOLOA

R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS

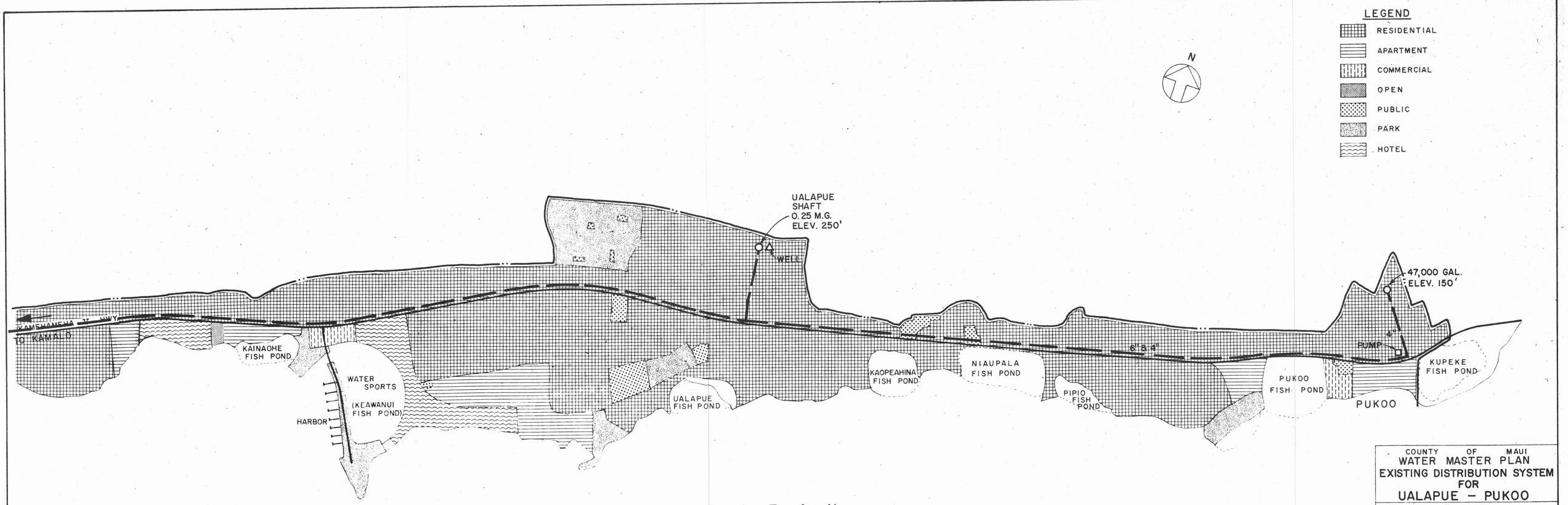
PLATE 49



COUNTY OF MAUI
WATER MASTER PLAN
EXISTING DISTRIBUTION SYSTEM
FOR
KAMALO

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 50



COUNTY OF MAUI
WATER MASTER PLAN
EXISTING DISTRIBUTION SYSTEM
FOR
UALAPUE – PUKOO

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 51

e. Future Consumption

The projected mean daily demand for 1980 is estimated at 1.09 MGD for Kaunakakai and 1.60 MGD for Pukoo. This is higher than the Department of Land and Natural Resources figures from the report, "A Domestic Water Plan for Kaunakakai-Pukoo." In that report, a high of 0.9 MGD for Kaunakakai and 0.5 MGD for Pukoo area was projected.

The difference in estimated water demand can be attributed to the different methods of predicting population growth and water consumption. The report, "A Domestic Water Plan for Kaunakakai-Pukoo," predicted the water consumption rate on a 150 gallon per capita per day basis, together with the population projection of the State General Plan. In comparison, this report bases its water demand on a percentage of ultimate land use and water consumption on a per acre basis.

The projected mean daily flow for 1990 is 2.17 MGD for the Kaunakakai area and 3.23 MGD for the Pukoo area (Tables I-31 and I-32). The present maximum demand is estimated at 3.26 MGD for Kaunakakai and 4.84 for Pukoo with the peak hourly demand estimated at 5.43 MGD for Kaunakakai and 8.07 MGD for Pukoo (Table I-33).

f. Source

In the Kaunakakai area, a source of water will have to be developed to bring the system up to a 2.2 MGD capacity.

The Department of Land and Natural Resources report on Kaunakakai-Pukoo states that additional water can be developed in the area around the Ualapue Well. It also states that this could be accomplished by the wells farther eastward.

The development of ground water for Kaunakakai and Pukoo seems to be most feasible as a source of water.

g. Proposed Development

The proposed installation is illustrated schematically on Plate 52 with the development plan shown on Plates 53, 54, 55 and 56.

It is proposed that the Kaunakakai-Pukoo system be developed in four stages.

(1) Stage I

(a) Install 13,000 linear feet from Uwalapae to existing service line.

(b) Install approximately 13,000 linear feet of 12" pipeline to Ualapue towards Pukoo.

(c) Development of a 0.5 MG storage tank at Ualapue.

(d) Developent of a 1.0 MG well, pump and control at Ualapue.

(e) Install approximately 2,000 linear feet of 12" pipeline from tank to main.

(f) Install approximately 9,000 additional linear feet to 12" pipeline from main at Ualapue towards Kamalo.

(2) Stage II

(a) Development of 0.5 MG storage tank at Kawela.

(b) Development of 0.5 MG well, pump and controls.

(c) Install approximately 2,000 linear feet of 12" pipeline from tank to main.

(d) Install approximately 8,000 linear feet of 12" pipeline at Kawela.

(e) Install approximately 20,000 linear feet of 8" pipeline from Kawela to Kamalo.

(3) Stage III

(a) Development of a 0.5 MG well at Pukoo.

(b) Development of a 0.5 MG storage tank at Pukoo.

(c) Install approximately 1,000 linear feet of 12" pipeline from tank to main.

(d) Install approximately 1,000 linear feet of 12" pipeline from Pukoo towards Ualapue.

(e) Development of a 2.0 MG storage tank at Kamalo.

(f) Install approximately 3,500 linear feet of 16" pipeline from tank to main.

(g) Development of a 0.5 MG storage tank at Ualapue.

(h) Install approximately 1,000 linear feet extension of 12" Pookoo pipeline from tank to main.

(4) Stage IV

(a) Install approximately 1,500 linear feet of 12" pipeline from tank to main at Kaunakakai.

(b) Install approximately 9,000 linear feet of 12" pipeline from Kaunakakai to Kamiloloa.

(c) Install approximately 8,000 linear feet of 12" pipeline from Kamiloloa towards

(d) Install approximately 4,000 linear feet of 8" pipeline from 12" main to existing 8" main.

(e) Development of a 0.5 MG storage tank at Kawela.

(f) Install approximately 2,000 linear feet of 12" pipeline from tank to main.

(g) Development of a 1.0 MG storage tank at Kamiloloa.

(h) Install approximately 2,500 linear feet of 12" pipeline from tank to main.

(i) Install approximately 5,000 linear feet of 12" pipeline at Kalanaanaole.

(j) Install approximately 9,000 linear feet of 8" pipeline at Kalanaanaole.

(k) Development of a 1.0 MG storage tank at Kalanaanaole.

TABLE NO. I-31
ADOPTED DESIGN CRITERIA
FOR
KAUNAKAKAI-PUKOO

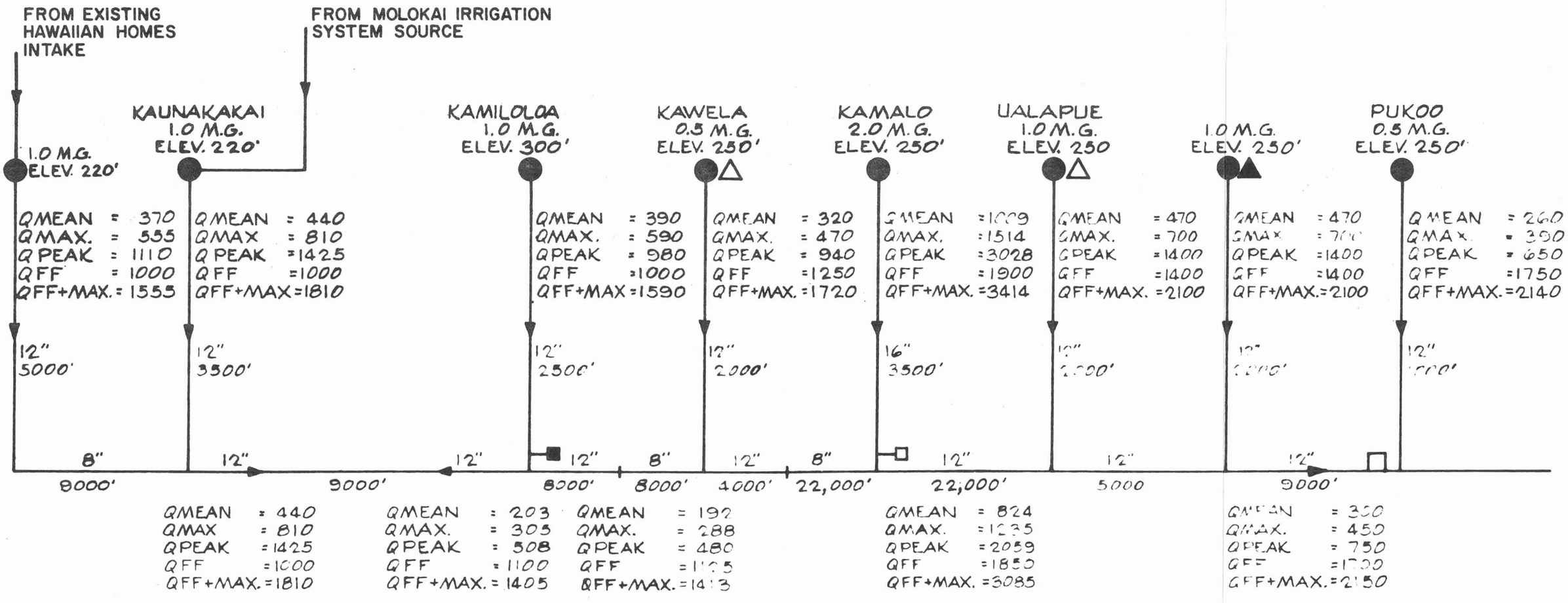
Area	Land Use	Per Acre	GPCD	GPAD	1980 35% of Max Development Acres	1980 35% of Max Development Population	1980 35% of Max Development Flow	1990 70% of Max Development Acres	1990 70% of Max Development Population	1990 70% of Max Development Flow	Max Development (2,000) Acres	Max Development (2,000) Population	Max Development (2,000) Flow
# 1 to # 5	Residential	13	140	1800	115.9	1507	0.2086	231.7	3012	0.4171	331.0	4303	0.5958
	Industrial	-	-	6000	8.0	-	0.0480	16.0	-	0.0960	22.8	-	0.1368
	Public	-	-	1700	4.8	-	0.0082	9.5	-	0.0162	13.6	-	0.0816
	SUBTOTAL	-	-	-	128.7	1507	0.2648	257.2	3012	0.5293	367.4	4303	0.8142
#6 to ½#18	Residential	13	140	1800	47.3	615	0.0851	94.5	1229	0.1701	135.0	1755	0.2430
	Apartment	40	140	5600	9.7	388	0.0543	19.4	776	0.1086	27.7	1108	0.1551
	Commercial	-	-	6000	11.6	-	0.0696	23.2	-	0.1392	33.2	-	0.1992
	Industrial	-	-	6000	12.5	-	0.0750	24.9	-	0.1500	35.6	-	0.2136
	Public	-	-	1700	14.4	-	0.0245	30.9	-	0.0490	44.1	-	0.0750
	SUBTOTAL	-	-	-	95.5	1003	0.3085	192.9	2005	0.6169	275.6	2863	0.8859
½#18 to #28	Residential	13	140	1800	140.0	1819	0.2519	279.9	3638	0.5038	399.9	5199	0.7198
	Apartment	40	140	5600	9.7	388	0.0543	19.5	776	0.1086	27.8	1116	0.1556
	Hotel	-	-	17000	13.4	-	0.2278	26.7	-	0.4556	38.2	-	0.6494
	SUBTOTAL	-	-	-	163.6	2207	0.5340	326.1	4414	1.0680	465.9	6315	1.5248
#29 to #39	Residential	13	140	1800	145.1	1886	0.2612	290.2	3773	0.5224	414.5	5389	0.7461
	Commercial	-	-	6000	22.7	-	0.1362	45.4	-	0.2724	64.8	-	0.3888
	Hotel	-	-	17000	19.4	-	0.3298	38.8	-	0.6596	55.4	-	0.9418
	SUBTOTAL	-	-	-	187.2	1886	0.7272	374.4	3773	1.4544	534.7	5389	2.0767

TABLE NO. I-32
ADOPTED DESIGN CRITERIA
FOR
KAUNAKAKAI-PUKOO

Area	Land Use	Per Acre	GPCD	GPAD	1980 35% of Max Development			1990 70% of Max Development			Max Development (2,000)		
					Acres	Population	Flow	Acres	Population	Flow	Acres	Population	Flow
#40 to #48	Residential	13	140	1800	199.7	2596	0.3595	399.4	5192	0.7189	570.5	7417	1.0269
	Hotel	-	-	17000	18.6	-	0.3162	37.1	-	0.6324	53.0	-	0.9010
	Public	-	-	1700	5.6	-	0.0095	11.2	-	0.0190	16.0	-	0.0272
	SUBTOTAL	-	-	-	223.9	2596	0.6852	447.7	5192	1.3703	639.5	7417	1.9551
#49 to #56	Residential	13	140	1800	58.8	764	0.1058	117.6	1529	0.2117	168.0	2184	0.3024
	Apartment	40	140	5600	9.3	372	0.0521	18.6	744	0.1042	26.6	1064	0.1490
	Commercial	-	-	6000	2.5	-	0.0150	4.9	-	0.0300	7.0	-	0.0420
	Public	-	-	1700	3.3	-	0.0056	6.6	-	0.0112	9.4	-	0.0160
	SUBTOTAL	-	-	-	73.9	1136	0.1785	147.7	2273	0.3571	211.0	3248	0.5094
	GRAND TOTAL (Tables I-31 and I-32)	-	-	-	872.8	10335	2.26980	1746.0	20669	5.3960	2494.1	29515	7.7661

TABLE NO. I-33
ADOPTED DESIGN CRITERIA
FOR
KAUNAKAKAI-PUKOO

AREA	POPULATION		ESTIMATED WATER DEMAND									STORAGE			
			Mean Daily		Max Day		Peak Hourly		Fire Flow		Duration	Fire Flow		Peak Flow	
	1980	1990	1980	1990	1980	1990	1980	1990	1980	1990	Hours	Req'd	Exist.	Req'd	New
# 1 to # 5	1,507	3,012	0.265	0.529	0.398	0.794	0.795	1.587	-	-	-	-	-	-	-
#6 to ½#18	1,003	2,005	0.309	0.617	0.464	0.926	0.927	1.851	1,630	2,250	9.0	1.22	-	0.86	2.0
½#18 to #28	2,007	4,414	0.534	1.068	0.801	1.602	1.602	3.204	1,500	2,100	8.4	1.06	0.10	0.80	2.0
#29 to #39	1,886	3,773	0.727	1.454	1.091	2.181	2.181	4.362	1,440	1,900	7.8	0.89	0.05	1.90	2.0
#40 to #48	2,596	5,192	0.685	1.370	1.028	2.055	2.055	4.110	1,650	2,800	9.2	1.55	0.07	1.03	2.0
#49 to #56	1,136	2,273	0.179	0.357	0.269	0.536	0.537	1.071	1,068	1,573	6.3	0.60	0.047	0.27	0.5
TOTAL	0,135	20,669	2.699	5.395	4.051	8.094	8.097	16.185	7,288	10,623	40.7	5.34	0.267	4.050	8.5

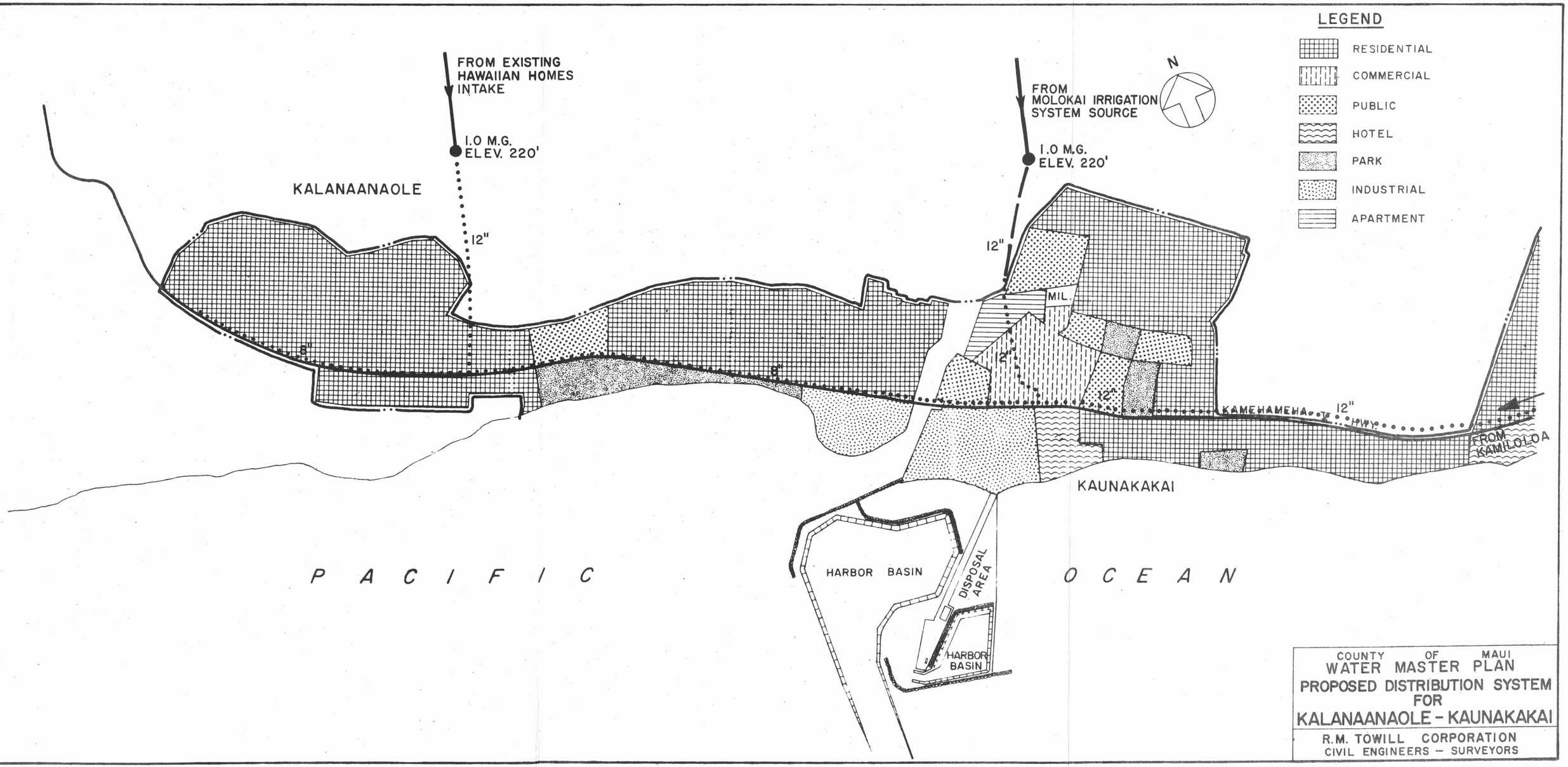


NOTE: FLOW IN GPM

COUNTY OF MAUI
WATER MASTER PLAN
SCHEMATIC DIAGRAM FOR
WATER SYSTEM PROPOSAL
FOR
EAST MOLOKAI

R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS

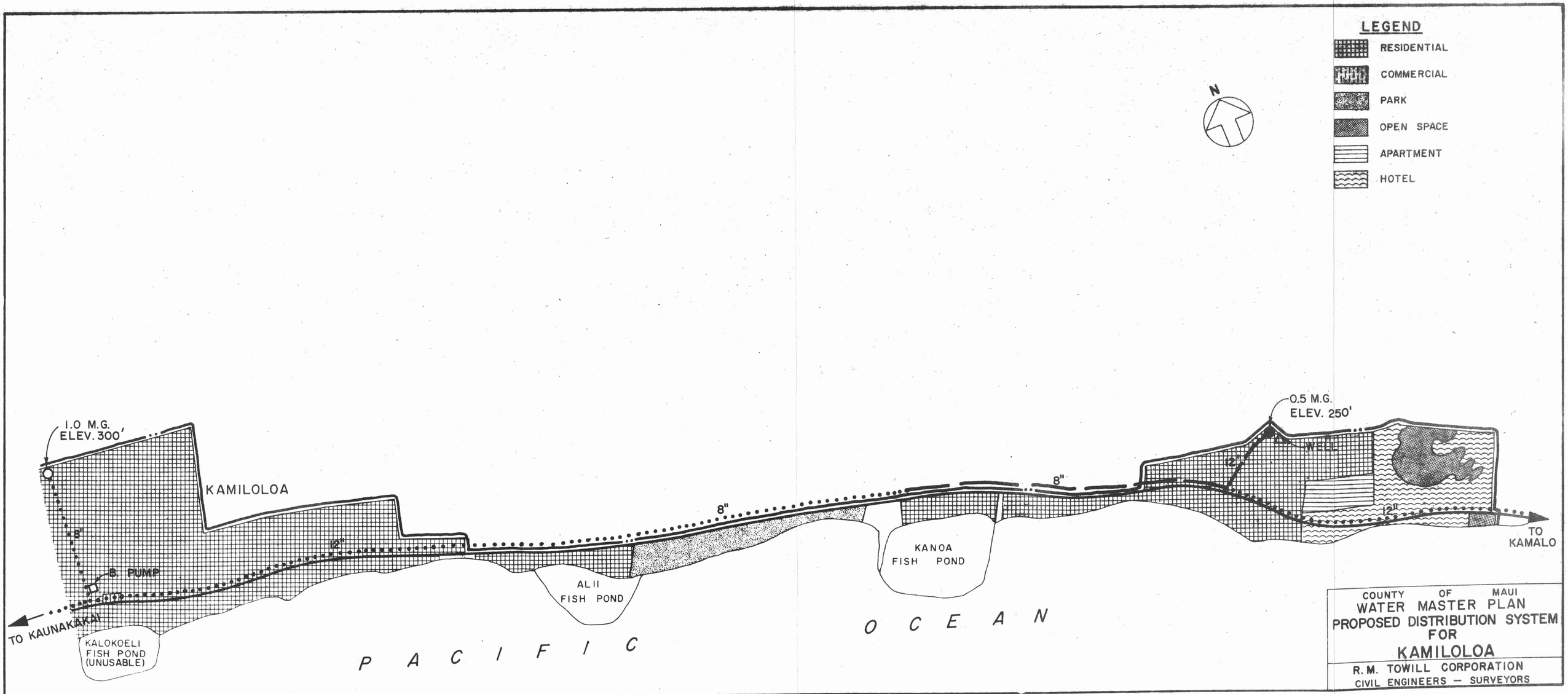
PLATE 52



COUNTY OF MAUI
WATER MASTER PLAN
PROPOSED DISTRIBUTION SYSTEM
FOR
KALANAANAOLE - KAUNAKAKAI

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

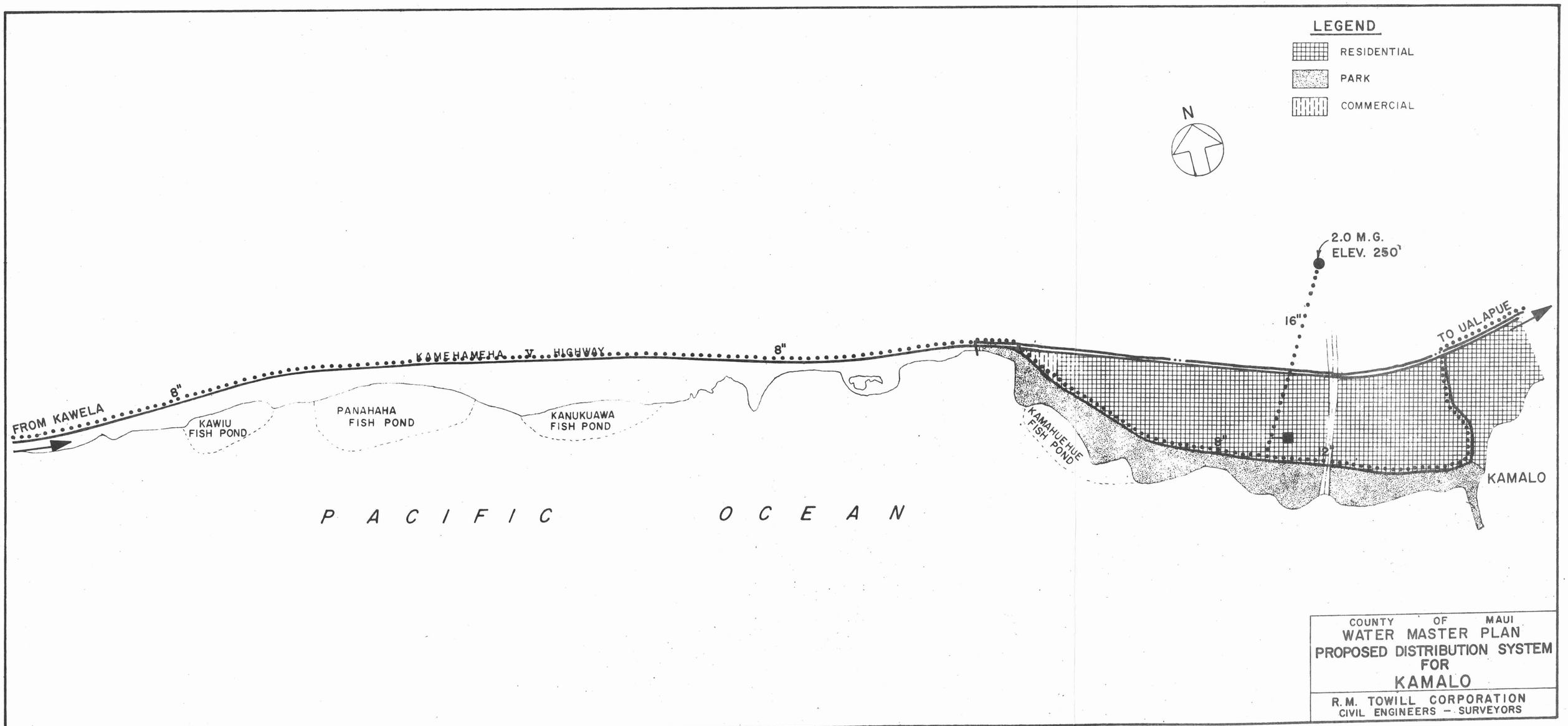
PLATE 53



COUNTY OF MAUI
WATER MASTER PLAN
PROPOSED DISTRIBUTION SYSTEM
FOR
KAMILOLOA

R. M. TOWILL CORPORATION
CIVIL ENGINEERS — SURVEYORS

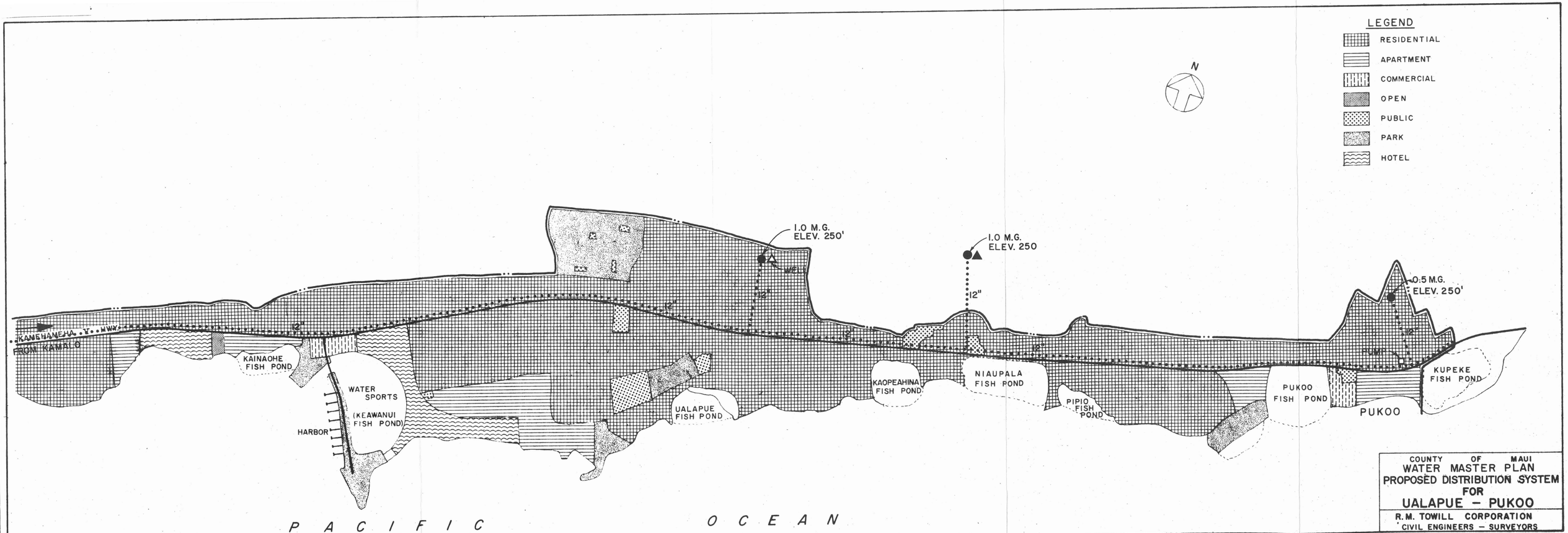
PLATE 54



COUNTY OF MAUI
WATER MASTER PLAN
PROPOSED DISTRIBUTION SYSTEM
FOR
KAMALO

R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 55



COUNTY OF MAUI
WATER MASTER PLAN
PROPOSED DISTRIBUTION SYSTEM
FOR
UALAPUE – PUKOO
R.M. TOWILL CORPORATION
CIVIL ENGINEERS – SURVEYORS

PLATE 56

II. COST ESTIMATES

A. GENERAL CONDITIONS

The preliminary construction cost estimates have been completely based on the current construction cost and summarized in order to evaluate the economic feasibility of the alternative plans and establish the total cost of the chosen final plan. Escalation of the adjustments should be made for the year in which the items are actually constructed.

In order to prepare the cost estimate for the construction, manufacturers and suppliers of various construction materials, equipment, and facilities were contacted and the estimated costs for this report are developed from the latest information available for work being performed in that area. Fifteen percent of the construction cost is estimated for contingencies and engineering and has not been added to the total estimated construction costs. No monies are considered for land acquisition. Shipping costs for materials are included in the construction prices.

TABLE NO. II-1

COST ESTIMATES

WAILUKU-KAHULUI

	STAGE I		
1.	Increasing capabilities of Mokuhau Wells to 10.0 MGD capacity	=	$ 40,000
2.	20" pipeline to parallel the existing 16" pipeline along North Market and Vineyard Sts. 1,200 LF @ $50.00/LF	=	60,000
3.	12" pipeline along lower Main Street 5,000 LF @ $25.00/LF	=	125,000
4.	The installation of approximately 3,000 feet of 12" pipeline along Piihana Street LF @ $25.00/LF	=	75,000
	SUB TOTAL	=	$ 300,000
	STAGE II		
1.	8" pipeline along Liholiho Street 4,000 LF @ $15.00/LF	=	$ 60,000
2.	16" pipeline from 24" diameter transmission main to proposed 3.0 MG storage tank at Kahului 2,000 LF @ $38.00/LF	=	76,000
3.	3.0 MG storage tank at Kahului	=	588,000
4.	18" pipeline at Kahului 15,000 LF @ $44.00/LF	=	660,000
5.	18" pipeline from Mokuhau Wells 4,900 LF @ $44.00/LF	=	215,600
	SUB TOTAL	=	$1,599,600

TABLE NO. II-1 (Continued)

STAGE III

1.	2.0 MG well at Kapaniwai	=	$ 230,000
2.	2.0 MG storage tank at Kahului	=	400,000
3.	12" pipeline at Kahului 18,000 LF @ $25.00/LF	=	450,000
4.	16" pipeline at Kahului 9,000 LF @ $38.00/LF	=	228,000
5.	1.0 MG storage tank at Mokuhau Wells	=	230,000
6.	2.0 MG well at Happy Valley	=	400,000
7.	12" pipeline from well at Happy Valley 15,000 LF @ $25.00/LF	=	375,000
8.	1.5 MG storage tank at Wailuku	=	320,000
9.	12" pipeline parallel to Kahului Beach Road 5,000 LF @ $25.00/LF	=	125,000
10.	12" pipeline along Kanaloa Ave. 5,000 LF @ $25.00/LF	=	125,000
11.	12" pipeline along Kaahumanu Ave. 6,000 LF @ $25.00/LF	=	150,000
	SUB TOTAL	=	$3,033,000

TABLE NO. II-2

COST ESTIMATES

PAIA

	STAGE I			
1.	12" pipeline along Hana Highway 2,000 LF @ $25.00/LF		=	$ 50,000
2.	8" pipeline from Paia to Kuau 9,000 LF @ $15.00/LF		=	135,000
		SUB TOTAL	=	$ 185,000
	STAGE II			
1.	12" pipeline along Baldwin Highway at Paia 8,000 LF @ $25.00/LF		=	$ 200,000
2.	1.0 MG storage tank at Paia		=	230,000
3.	16" pipeline Kahului to Airport Area 14,000 LF @ $38.00/LF		=	532,000
4.	12" pipeline from Airport to Paia 15,000 LF @ $25.00/LF		=	375,000
		SUB TOTAL	=	$1,337,000
	STAGE III			
1.	0.5 MG Pumping Station		=	$ 100,000
2.	12" pipeline from Paia to Upper Paia 5,500 LF @ $25.00/LF		=	137,500
3.	0.5 MG storage tank at Upper Paia		=	140,000
		SUB TOTAL	=	$ 377,500
		TOTAL	=	$1,899,500

TABLE NO. II-3

COST ESTIMATES

WAILUKU-KAHULUI

WAIHEE

STAGE I

1.	0.25 MG storage tank at Waihee	=	100,000
2.	12" pipeline from 8" transmission main to 0.25 storage tank. 1,500 LF @ $25.00/LF	=	37,500
	TOTAL	=	$ 137,500

TABLE NO. II-4

COST ESTIMATES

LAHAINA-KAANAPALI-NAPILI

STAGE I

1.	The drilling of a 1.0 MG well at Napili	=	$ 180,000
2.	Installation of approximately 5,000 to 6,000 linear feet of 12" pipeline leading from the well to the transmission main	=	150,000
3.	Development of a 1.0 MG storage tank above Alaeloa	=	230,000
4.	The drilling of a second 1.0 MG well at Napili	=	180,000
	SUBTOTAL	=	$ 740,000

STAGE II

1.	Installation of 3,000 linear feet of 12" pipeline from the storage tank above Alaeloa to Honoapiilani Highway	=	$ 75,000
2.	Installation of 14,000 linear feet of 16" pipeline along Honoapiilani Highway from Kanaha to Honokowai	=	532,000
3.	A 1.0 MG storage tank is to be installed above Honokowai, and 3,000 linear feet of 12" pipeline from the tank to Honokowai	=	75,000
4.	Installation of a second 1.0 MG storage tank at the proposed site above Alaeloa	=	230,000
	SUBTOTAL	=	$ 912,000

STAGE III

1.	Development of the area from Napili Bay to Honokahau Bay by Maui Land & Pineapple Company		
2.	Development of a 3 MGD well, a 3 MG storage tank and the installation of approximately 11,000 linear feet of 16" pipeline and 9,000 linear feet of 12" pipeline	=	$1,531,000

TABLE NO. II-4 (Cont.)

The proposed development for the LAHAINA area is as follows:

STAGE I

1.	Installation of a 0.5 MG storage tank at Lahaina with approximately 1,500 linear feet of 16" pipeline to the existing 10" transmission main	=	$ 197,000
2.	Development of the Kanaha well, the completion of approximately 2,500 linear feet of 12" pipeline from the well to the pipeline installed in item (a) above, and the installation of a 0.5 MG reservoir at Lahaina	=	402,000
3.	Development of the second Kanaha well and the installation of approximately 2,000 linear feet of 8" pipeline to the 12" pipeline installed in item (2) above	=	230,000
4.	Installation of approximately 5,100 linear feet of 16" pipeline from the 0.5 MG reservoir established in item (1) above to Front Street	=	193,800
	SUBTOTAL	=	$1,022,800

STAGE II

1.	Installation of approximately 13,000 linear feet of 12" pipeline and 3,200 linear feet of 8" pipeline within Lahaina	=	$ 373,000
2.	Provide a 1.0 MG storage tank elevation 250 feet and the installation of approximately 6,000 linear feet of 12" pipeline from the 16" transmission main installed as Item I 4 above to the existing 1.5 MG storage tank at elevation 250 feet	=	380,000
3.	Installation of a third well to service the Lahaina area (not indicated on plan	=	200,000
4.	Development of a 1.0 MG storage tank and approximately 6,000 linear feet of 16" pipeline from this well site/reservoir to the second Kanaha well	=	380,000
	SUBTOTAL	=	$1,153,000
	GRAND TOTAL	=	$5,358,800

TABLE NO. II-5

COST ESTIMATES

MAALAEA-MAKENA

The development of the KIHEI area is proposed in the following stages:

STAGE I

1.	Development of a 3.0 MG storage tank at north Kihei	= $	588,000
2.	Installation of 6,000 feet of 16" pipeline from the tank to the existing pipeline	=	228,000
3.	Development of a 2.0 MG storage tank at Waialia	=	400,000
4.	Installation of 23,000 feet of 18" pipeline from Kamaole to Makena	=	1,012,000
	SUBTOTAL	=	$2,228,000

STAGE II

1.	Drilling of a 3.0 MGD well at upper Kihei	= $	300,000
2.	Installation of 16,000 feet of 12" pipeline from the well to Kihei	=	400,000
3.	Drilling of a 9.0 MGD well source at Waikapu	=	550,000
4.	Installation of 2,000 feet of 24" pipeline from Waikapu wells to the existing 18" pipeline from Waikapu wells to the existing 18" pipeline (Plate 28)	=	132,000
	SUBTOTAL	=	$1,382,000

TABLE NO. II-5 (Cont)

STAGE III

1.	The increasing of Waikapu source by 3.0 MGD	=	$ 200,000
2.	The installation of 43,500 feet of 24" pipeline from Waikapu to Kihei	=	2,871,000
3.	Development of a 1.0 MG storage tank at south Kihei including 4,000 feet of 16" pipeline from the tank to the existing 18" pipeline	=	152,000
4.	Development of a second 2.0 MG storage tank at Waialea and approximately 3,000 feet of 16" pipeline from the tank to 18" pipeline installed in Stage I, Item 4.	=	514,000
	SUBTOTAL	=	$3,737,000

STAGE IV

1.	Development of a third 2.0 MG storage tank at Waialea; and approximately 2,000 feet of 16" pipeline from the storage tank to the 18" line installed in Stage I, Item 4	=	476,000
2.	Installation of 26,000 feet of 24" pipeline from Kihei to Kamaole	=	1,716,000
3.	Development of an additional 2.0 MG storage tank at south Kihei	=	400,000
	SUBTOTAL	=	$2,592,000

STAGE V

	The installation of a 0.5 MG storage tank at approximately elevation 700 feet above Waialea, the completion of a 0.3 MG storage tank at elevation 558 in this same area and the installation of approximately 3,000 feet of 12" pipeline between these two storage facilities	=	345,000

The development for the MAALAEA area is proposed as follows:

TABLE NO. II-5 (Cont.)

	STAGE I		
	Installation of approximately 6,500 feet of 8" pipeline and the installation of approximately 2,300 linear feet of 12" pipeline. Provide a 0.7 MG storage reservoir as shown on Plate 25	=	355,000
	The development for the MAKENA area is proposed as follows:		
	STAGE I		
1.	Development of a 3.0 MG storage tank at Makena and approximately 3,000 feet of 20" pipeline from tank to 18" main	=	756,000
2.	The increasing of the Waikapu wells by 5.0 MGD	=	250,000
3.	Installation of approximately 13,500 linear feet of 12" pipeline from Makena to Ahihi Bay	=	337,500
	SUBTOTAL	=	$1,343,500
	GRAND TOTAL	=	$11,982,500

TABLE II-6

COST ESTIMATES

HAIKU

STAGE I

1.	8" pipeline to Haiku School. 6,000 LF @ $15.00/LF		= $ 90,000
2.	8" pipeline to Haiku from intake. 6,000 LF @ $15.00/LF		= 90,000
		SUB TOTAL	= $ 180,000

STAGE II

1.	12" pipeline to Haiku-Haiku School. 4,000 LF @ $25.00/LF		= 100,000
2.	8" pipeline within Haiku. 6,000 LF @ $15.00/LF		= 90,000
		SUB TOTAL	= $ 190,000

STAGE III

1.	8" pipeline below Haiku. 3,000 LF @ $15.00/LF		= 45,000
2.	1.0 MG storage tank above Haiku		= 230,000
		SUB TOTAL	= $ 275,000
		GRAND TOTAL	= $ 645,000

TABLE II-7

COST ESTIMATES

MAKAWAO - KOKOMO

STAGE I

1.	12" pipeline from Olinda to Makawao. 6,000 LF @ $25.00/LF	= $ 150,000
2.	4.5 MG Pump at Alelele	= 160,000
3.	16" pipeline from Kokomo to Makawao. 6,000 LF @ $38.00/LF	= 228,000
	SUB TOTAL	= $ 538,000

STAGE II

1.	3.5 MGD Proposed Water Treatment Plant	= 350,000
2.	20" pipeline to Kokomo. 9,000 LF @ $50.00/LF	= 450,000
3.	12" pipeline at Makawao. 6,000 LF @ $25.00/LF	= 150,000
4.	1.5 MG storage tank at Makawao	= 320,000
	SUB TOTAL	= $1,270,000

STAGE III

1.	4.0 MGD Proposed Water Treatment Plant	= 250,000
	GRAND TOTAL	= $2,058,000

TABLE II-8

COST ESTIMATES

PUKALANI

	STAGE I		
1.	16" pipeline to Pukalani. 8,000 LF @ $38.00/LF	=	$ 304,000
2.	1.0 MG storage tank near Haleakala Highway	=	230,000
3.	12" pipeline from 1.0 MG storage tank to 16" pipeline from Makawao 1,000 LF @ $25.00/LF	=	25,000
	SUB TOTAL	=	$ 559,000
	STAGE II		
1.	12" pipeline at Pukalani. 5,000 LF @ $25.00/LF	=	125,000
2.	0.5 MG Storage tank near Haleakala Highway. (Elev. 1422)	=	140,000
	SUB TOTAL	=	$ 265,000
	STAGE III		
1.	1.0 MG storage tank at Pukalani	=	230,000
2.	8" pipeline within Pukalani. 5,000 LF @ $15.00/LF	=	270,000
3.	12" pipeline within Pukalani. 14,000 LF @ $25.00/LF	=	75,000
4.	0.5 MG storage tank at Pukalani	=	350,000
5.	8" pipeline above Pukalani 4,000 LF @ $15.00/LF	=	60,000
6.	0.3 MG storage tank above Pukalani	=	100,000
	SUB TOTAL	=	$1,085,000
	GRAND TOTAL	=	$1,909,000

TABLE II-9

COST ESTIMATES

PAUWELA

	STAGE I		
1.	12" pipeline to Pauwela. 5,000 LF @ $25.00/LF		= $ 125,000
2.	8" pipeline to Pauwela. 7,000 LF @ $15.00/LF		= 105,000
		SUB TOTAL	= $ 230,000
	STAGE II		
1.	0.5 MG storage tank above Pauwela		= 140,000
2.	12" pipeline to Ulumalu-Pauwela. 12,000 LF @ $25.00/LF		= 300,000
		SUB TOTAL	= $ 440,000
		GRAND TOTAL	= $ 670,000

TABLE NO. II-10

COST ESTIMATES

HANA

	STAGE I		
1.	Development of a 1.0 MG well at Waikiu	=	$ 220,000
2.	Development of a 0.5 MG storage tank at Waikiu	=	180,000
3.	Installation of 2,400 feet of 12" pipeline from the tank to Hana Highway, 1,000 feet of 8" pipeline along Hana Highway to Hana School and 5,000 feet of 12" pipeline towards the Hana town area	=	240,000
4.	This phase includes 4,500 feet of 8" pipeline to Hana; 2,000 feet of 12" pipeline and 3,000 feet of 8" pipeline within Hana	=	195,000
	SUB TOTAL	=	$ 835,000
	STAGE II		
1.	Development of a 1.0 MG well above Hana	=	$ 220,000
2.	Development of a 1.0 MG storage tank above Hana	=	280,000
3.	Installation of 2,000 feet of 12" pipeline from the tank to Hana	=	60,000
	SUB TOTAL	=	$ 560,000
	STAGE III		
1.	Development of a 0.5 MG storage tank at Waikui	=	$ 180,000
2.	Installation of 11,000 feet of 8" pipeline at Mokae	=	198,000
3.	Development of a 0.25 MG pump on the 8" pipeline to Mokae and a 0.3 MG storage tank above Mokae	=	180,000
4.	Installation of 2,000 feet of 12" pipeline from the tank to Mokae, 1,400 feet of 12" pipeline and 3,400 feet of 8" pipeline at Mokae	=	247,000
	SUB TOTAL	=	$ 805,000
	GRAND TOTAL	=	$2,200,000

TABLE NO. II-11

COST ESTIMATE

KAUNAKAKAI-PUKOO

	STAGE I		
1.	Installation of 13,000 linear feet of 12" pipeline from Uwalapae to existing service line	=	$ 357,500
2.	Installation of approximately 13,000 linear feet of 12" pipeline to Ualapue towards Pukoo	=	357,500
3.	Development of a 0.5 MG storage tank at Ualapue	=	155,000
4.	Development of a 1.0 MG well, pump and control at Ualapue	=	198,000
5.	Installation of approximately 2,000 linear feet of 12" pipeline from tank to main	=	55,000
6.	Installation of approximately 9,000 additional linear feet to 12" pipeline from main at Ualapue towards Kamalo	=	247,500
	SUB TOTAL	=	$1,370,500
	STAGE II		
1.	Development of 0.5 MG storage tank at Kawela	=	$ 155,000
2.	Development of 0.5 MG well, pump and controls	=	175,000
3.	Installation of approximately 2,000 linear feet of 12" pipeline from tank to main	=	55,000
4.	Installation of approximately 8,000 linear feet of 12" pipeline at Kawela	=	220,000
5.	Installation of approximately 20,000 linear feet of 8" pipeline from Kawela to Kamalo	=	330,000
	SUB TOTAL	=	$ 935,000

TABLE NO. II-11(Continued)

STAGE III

1.	Development of a 0.5 MG well at Pukoo	=	$ 175,000
2.	Development of a 0.5 MG storage tank at Pukoo	=	155,000
3.	Installation of approximately 1,000 linear feet of 12" pipeline from tank to main	=	27,500
4.	Installation of approximately 1,000 linear feet of 12" pipeline from Pukoo towards Ualapue	=	27,500
5.	Development of a 2.0 MG storage tank at Kamalo	=	253,000
6.	Installation of approximately 3,500 linear feet of 16" pipeline from tank to main	=	146,300
7.	Development of a 0.5 MG storage tank at Ualapue	=	155,000
8.	Installation of approximately 1,000 linear feet extension of 12" Pukoo pipeline from tank to main	=	27,500
	SUB TOTAL	=	$ 966,800

TABLE NO. II-11(Continued)

STAGE IV

1.	Installation of approximately 1,500 linear feet of 12" pipeline from tank to main at Kaunakakai	=	$ 42,000
2.	Installation of approximately 9,000 linear feet of 12" pipeline from Kaunakakai to Kamiloloa	=	247,500
3.	Installation of approximately 8,000 linear feet of 12" pipeline from Kamiloloa towards	=	220,000
4.	Install approximately 4,000 linear feet of 12" pipeline from 12" main to existing 8" main	=	110,000
5.	Development of a 0.5 MG storage tank at Kawela	=	155,000
6.	Installation of approximately 2,000 linear feet of 12" pipeline from tank to main	=	55,000
7.	Development of a 1.0 MG storage tank at Kamiloloa	=	198,000
8.	Installation of approximately 2,500 linear feet of 12" pipeline from tank to main	=	69,000
9.	Installation of approximately 5,000 linear feet of 12" pipeline at Kalanaanaole	=	137,500
10.	Installation of approximately 9,000 linear feet of 8" pipeline at Kalanaanaole	=	148,500
11.	Development of a 1.0 MG storage tank at Kalanaanaole	=	198,000
	SUB TOTAL	=	$1,580,500
	GRAND TOTAL	=	$4,852,800

BASIC DESIGN CRITERIA

A. GENERAL

The development of the proposed Water Master Plan has been established upon the basic design criteria as outlined below.

B. WATER DEMAND

The water demands established in this report have been prepared from the following sources:

1. The General Land Use Plans established by the County of Maui for each of the areas considered.

2. The Zoning Ordinances as prepared by the County of Maui, Planning Department.

3. Basic Design Criteria established in previous reports prepared by consultant firms and government agencies for the design and evaluation of existing water distribution systems.

The mean daily water demand is bassed on the consumption rates and factors outlined in Table III-1. The consumptive rates were based on the land development of 70 percent by 1980 and 100 per cent by 1990 for the Wailuku-Kahului area and 35 percent and 70 percent development for 1980 and 1990, respectively, for the remainder of the County of Maui.

The mean daily flow is based on the various land use classifications. These land classifications are residential, apartment, hotel, commercial, industrial and public. Residential flow demands of 2,500 gallons per acre per day for Wailuku-Kahului and 1,800 gallons per acre per day for the remainder of the County of Maui are used. Other demand rates used are apartments, 5,600 gallons per acre per day; hotels, 17,000 gallons per acre per day; commercial and industrial, 6,000 gallons per acre per day; and public, 1,700 gallons per acre per day.

C. VARIATIONS IN RATE OF CONSUMPTION

The consumption rate varies with the season, day and hour. The water supply system must be capable of handling these variations in order to adequately meet the flow demands at a satisfactory pressures.

For this report, the maximum daily demand was taken at 1.5 times the mean (average) daily demand. The peak hourly demand was taken at 3.0 times the mean daily demand.

D. FIRE FLOW

The amounts of water utilized for fire flow during a year are relatively small compared to the actual amount of water consumed, but the rate of use during fire demand is high compared to the normal flow demand. The fire demand rate is based on the formula given by the National Board of Fire Underwriters, and a minimum flow of 1,000 gallons per minute is considered. The quantity of flow given by this formula is for principal commercial districts of an area.

The maximum daily flow was added to the fire flow to obtain the total required flow during fire demand.

E. SYSTEM PRESSURE

Excessively high and extremely low pressures in a water supply system are undesirable. With high pressures, the leakage factor of a system increases. The maximum pressure in a system has been kept approximately 110 psi with storage tanks located at an approximate elevation of 250 feet. The minimum pressure for fire flow has been kept at approximately 20 psi as recommended by the National Board of Fire Underwriters.

F. SYSTEM CAPACITIES

1. Pipeline Coefficient

In determining the pipeline size and hydraulic gradient, cast iron pipes were assumed, and a Hazen-Williams coefficient factor of 100 was utilized.

2. Size of Mains

The transmission mains are sizeo to provide for the maximum daily flow, with the distribution mains sized to carry the peak hourly flow or the fire plus the maximum daily flow. In most areas, the fire flow plus the maximum daily flow is the larger of the two flow requirements and is therefore utilized.

3. Storage Reservoirs

Storage reservoirs are sized for peak hourly flow times 6 hours duration, or fire flow times fire flow duration, or maximum daily flow or 1,000 gallons per subdivision lot whichever of the quantities is greater.

G. WATER QUALITY

The 1962 USPHS Drinking Water Standards are illustrated on Table II-2 of this section. Also included are chemical analyses from the Wailoa Ditch as tabulated on Table III-3. The Wailoa Ditch analyses were provided for this report by the County of Maui. The samples were taken August 28, 1956 and March 4, 1955, respectively.

TABLE III-1

DESIGN CRITERIA

Land Use	Population person/acre	Water Rate GPCD	GPAD
Residential	13 - 18	140	1,800-2,500
Apartment	40	140	5,000
Hotel	75	250	17,000
Industrial			6,000
Commercial			6,000
School & Church	70	30	1,700
Hospital	40	100	1,800

GPCD - Gallons per Capita Day

GPAD - Gallons per Acre Day

TABLE III-2

1962 USPHS DRINKING

WATER STANDARDS

Description	Maximum Permissible Amounts	
Turbidity	5	units
Color	15	units
Threshold Odor Number	3	
Alkyl Benzene Sulfonate (A.B.S.)	0.5	mg/L
Lead	0.05	mg/L
Arsenic	0.05	mg/L
Selenium	0.01	mg/L
Barium (Ba)	1.0	mg/L
Copper	1.0	mg/L
Iron	0.3	mg/L
Manganese	0.05	mg/L
Nitrate	45	mg/L
Zinc	5.0	mg/L
Chlorides	250	mg/L
Sulphate	250	mg/L
Phenols	0.001	mg/L
Total Dissolved Solids	500	mg/L

TABLE III-3

CHEMICAL ANALYSES OF ALL WATER SAMPLES (PARTS PER MILLION)

(By County of Maui, 1955 and 1956)

pH @ 30°C		6.7
Color		10
Odor		0
Turbidity		20
NO_2		0.4 ppm
NO_3		0.2 ppm
Hydroxide Alkalinity		0.0 ppm as $CaCO_3$
Bicarbonate Alkalinity		13.0 " " "
Total Alkalinity		13.0 " " "
Total Hardness		23.4 " " "
Total Solids		40.0 ppm
Loss on Ignition		16.0 ppm
SiO_2		1.2 ppm
Fe_2O_3 & Al_2O_3		0.4 ppm
Fe_2O_3		0.1 ppm
Al_2O_3		0.3 ppm
Ca		3.3 ppm
Mg		3.6 ppm
SO_4		3.8 ppm
Na & K		3.0 ppm
Chlorides		3.0 ppm
As	less than	0.01 ppm
F		0.2 ppm
Mn	less than	0.1 ppm
Pb	less than	0.025 ppm
Cu	less than	0.1 ppm
Zn	less than	0.025 ppm
Se	less than	0.05 ppm
Phenols	less than	0.005 ppm

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